PUBLIC WORKS

CITY COUNTY STATE

SPEEDY CONSTRUCTION *developed by war's necessity is now available for*

RAPID PERMANENT CONSTRUCTION IN PUBLIC WORKS

WHEN the World War armies moved forward, the big guns frequently demanded that concrete foundations be made available for use over night. Speed was imperative—action could not wait for ordinary concrete to harden. And a remarkable cement similar to Lumnite enabled the guns to fire within 24 hours.

This, and other similar performances, gave the impetus that has caused such cements to come into general use in Europe when speed in construction and immediate service of concrete work are required.

Twenty-eight-day concrete in 24 hours is now brought to America through Atlas Lumnite Cement. For street and road construction and repairs, for bridges and culverts, street railway construction and maintenance, sewers and conduits—Lumnite offers big savings of time and money. It also supplies greater convenience to the public by producing 28-day concrete in 24 hours on any type of construction.

Write for the Lumnite Booklet
"28-day Concrete in 24 Hours."

THE ATLAS LUMNITE CEMENT CO.
25 Broadway, New York City

134 So. LaSalle Street
Chicago, Ill.

2000 First Avenue
Birmingham, Ala.

JUNE, 1925

Austin Leaning Wheel Graders

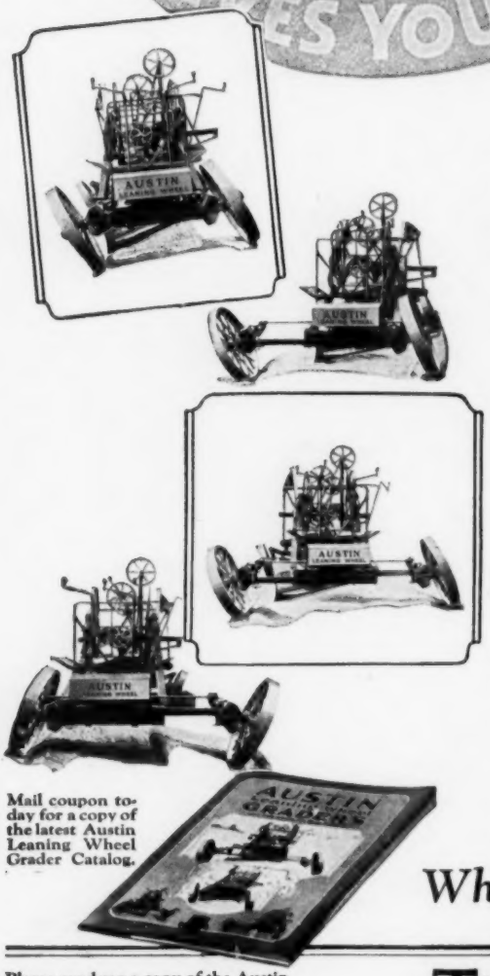
The time-tested features that have made Austin Graders the choice of experienced operators for over 40 years will all be found on the Leaning Wheel models. In addition, they are distinguished from all other Leaning Wheel graders by several improvements of great practical value. The Telescopic Rear Axle, Timken Tapered Roller Bearings and Alemite High Pressure Lubricating System are exclusive features whose value will be admitted by all impartial authorities.

The advantages of the telescopic axle are obvious. It is never in the way as a long, one-piece axle is very apt to be, and when fully telescoped has the further advantage of being much stronger than any long axle can hope to be.

Timken Tapered Roller Bearings are dust-tight and have many mechanical advantages over all other types. No other bearing is designed to stand the variable loads, or pressure, to which all grader wheels are subjected, and no other type can be taken up for wear instead of replaced.

The Alemite High Pressure Lubricating System is standard equipment on more than 250 automobiles, trucks and tractors. Its chief advantage is the fact that lubricant is forced into all bearings under a pressure of several hundred pounds to the inch, thus reaching every part of the wearing surface, and at the same time forcing out all foreign matter.

The Telescopic Rear Axle, Timken Bearings and Alemite Lubricating System are but three of the things that contribute to Austin superiority.



Mail coupon today for a copy of the latest Austin Leaning Wheel Grader Catalog.

Why take less in a leaning wheel machine?

Please send me a copy of the Austin Leaning Wheel Grader Catalog.

_____

_____

THE AUSTIN-WESTERN ROAD MACHINERY CO.

CHICAGO

VOL. 56 NO. 6

Entered as second-class matter at the Post Office, at New York, N. Y., Sept. 1, 1922, under the Act of March 3, 1879.
Published monthly by **PUBLIC WORKS JOURNAL CORPORATION**, 243 West 39th Street, New York, N. Y.
Subscription price $3.00 a year, single copies 35 cents.
JUNE, 1925

PUBLIC WORKS
CITY COUNTY STATE
A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"
Vol. 56 JUNE, 1925 No. 6

Orlando Water and Light Plant*

Water supply from lakes rather than from ground because softer and probably purer. Purified by means of aeration and filtration. Interesting construction features

By W. W. Mathews.†

Orlando, Fla., determined in 1921 upon municipal ownership of the water and light plant which had been built in the 80's but had been greatly outgrown, since the owners found themselves unable to comply with the franchise and meet the financial burdens imposed by the reconstruction of the plant which had become imperative. The population of the city had increased 137% from 1910 to 1920 and since the latter year has grown at the rate of about 20% per year, as indicated by the number of services and consumption of both water and electricity.

The city and the company owning these utilities agreed to arbitrate on the value of the properties with a view to purchase by the municipality and an arbitration board consisting of Cecil F. Elmes, L. R. Howson and Dabney H. Maury, all of Chicago, reached unanimous agreement as to the value, and the plants were taken over in 1922. The city commissioners appointed a utilities commission of five prominent citizens to operate the utilities, and this Commission employed Alvord, Burdick & Howson of Chicago as its engineering advisors.

It was realized that radical enlargement and improvement of both plants was immediately imperative. The electric plant could not meet the requirements even with all units in service, and half of the water supplied to consumers was unfiltered because of the inadequacy of the filter plant.

The determination of the capacity desirable for each plant was difficult because of the recent phenomenal growth of the city as well as of the other cities of the state. The population in 1920 was given by the United States census as 9,282 and it was estimated that by 1950 it would be 50,000; and it was decided to design the improvements with immediate capacity for 30,000 people.

GENERATOR AND PUMP ROOM, VIEWED FROM OPERATING FLOOR. 1,500 K.W. TURBO-GENERATOR BEING ERECTED.

SOURCE OF WATER SUPPLY

The water supply required considerably more study than did the power plant. There were two available sources of supply—groundwater and water from one or more of the numerous lakes in the vicinity, seventeen of these being within the city limits. Ground-water was available

*Abstract of a paper before the Illinois Section, American Waterworks Association.

†Assistant Engineer with Alvord, Burdick & Howson, Chicago.

in large quantities by means of wells, but such water was not so soft and otherwise desirable as the water from the lakes, and there was a possibility of pollution of ground water by the sewage of the city, which, after being clarified by Imhoff tanks, is discharged into wells and soaks way into the soil. The water in the lakes which were selected as most desirable had a hardness of approximately 20 parts per million, 41 parts per million of encrusting solids, and alkalinity with phenolphalein of zero and with methyl orange of about 10 parts per million. The top soil is all sand and there is no surface runoff, but an average annual rainfall of sixty inches per year percolates through the sand to the lower impervious stratum and thence into the lakes. A chain of lakes was selected, the drainage area of which would supply the needs of Orlando for at least twenty to thirty years, while a lake about two miles east of the city and 25 feet higher could easily be brought into these lakes by a gravity conduit. The lakes provide a natural storage of 1300 million gallons.

THE NEW STATION

It was found impracticable to use any of the old power plant, the pumping station or the filter plant, and an entirely new plant was built on the shore of Lake Ivanhoe, one of the chain of lakes which furnished the supply, the power, pumping and mechanical filter plants all being located here under one roof.

Owing to the fact that Orlando is a winter resort, that the packing houses from which citrus fruits are shipped operate almost exclusively during the winter season, and that the dry season occurs at the same time and lawn-sprinkling is then more general, the average daily consumption increases about 100% for short periods and the electric load also doubles in the winter time and provision, of course, was necessary for these unusually high peak loads.

Bids were asked for building the plant, but as contractors bidding on the building and coagulating basin did not guarantee a time of completion, the city decided to do the work by day labor under the supervision of the engineers. Both electric and filter plants were completed in June, 1923 and have been operating since that time.

The station building is 172 feet 6 inches long by 98 feet wide and provides a space not only for the immediate installations, but also for a reasonable amount of future extension. The pumping equipment is in the center of the building, the boilers and electrical equipment in the western portion and the purification plant in the eastern portion.

As the building stands between a large lake and the Dixie Highway and is visible for a half mile north and south on the latter and from across the lake, and was thus the most prominent feature of the landscape, it was thought desirable to pay special attention to its architectural appearance. The type of architecture adopted was that developed during the Spanish era in Florida. The building is constructed mainly of reinforced concrete with some amount of brick, and is finished outside with white stucco. The visible roofs of the building are covered with red Spanish tile. Entrance to the building is through a tile paved portal embellished with stone carving and iron railings. Entrance to the generator and pump room is through an attractive lobby whose walls and groined arched ceilings are treated to imitate cut stone. In the center of the lobby is a handsomely carved drinking fountain. The floors of the lobby, generator and pump room are finished with red quarry tile.

The walls of the generator and pump room are finished in white paint above an olive green wainscoting, the latter color being used also for wrought iron work and machinery foundations. Auxiliaries, low-lift pumps and high voltage equipment are housed in a basement, and particular attention was given to lighting and ventilation, windows being placed on the front and south sides and large pit openings in the main floor above the basement.

Because of the warm climate, the unusual feature was introduced in the boiler room of large arched openings in place of glazed windows, these being equipped with wrought iron grills typically Spanish in treatment. These not only fit in with the architectural treatment and afford abundant ventilation and light, but they also provide a practical means of moving the equipment in or out of the boiler room. The architectural features of the building were designed by V. A. Matteson of Chicago.

THE PLANT

The units installed in the new plant were as follows: Three 512-horsepower Springfield Boiler Company water-tube boilers equipped with Power Specialty Company superheaters, Vulcan soot blowers and Schuette & Koerting oil burners. A working presure of 225 pounds per square inch with 100 degrees superheat is maintained. Oil was adopted as a fuel because more economical than coal at the prices of those two materials in Florida. Oil is pumped to the burners at 175 pounds pressure per square inch after being heated to 225 to 250 degrees F. Vaporization is effected by pressure and temperature only. Changes in load conditions are met by changing the tips, these being furnished with orifices varying from 0.75 to 2.5 millimeters diameter. Only a few seconds of time is required to change one of the tips, and this feature is found very convenient for meeting peak loads of the electric plant which come on very quickly. The oil burning plant gives the boiler-room a roomy and clean appearance. The walls were finished in white and are still white after over a year of use.

The generating equipment consists of two new 1500-k.w., 2300-volt, a.c. Westinghouse turbo-generators, and one 1,000-k.w., 2300-volt, a.c. General Electric turbo-generator brought from the old plant. C. H. Wheeler surface condensers were supplied with the Westinghouse unit and a Westinghouse jet condenser with

the General Electric generator. Two d.c. exciters were installed, one a turbo-generator of 50-k.w. capacity and the other a motor generator set of 60-k.w. capacity.

Three low-lift pumps and three high-lift pumps, all motor-driven centrifugal, and a small motor-driven wash-water pump comprise the pumping outfit. The low-lift and high-lift pumps have capacities of 3,000,000 gallons each against heads of 35 and 150 feet, respectively. These pumps were furnished by the Morris Machine Works. In addition to these pumps, three steam pumps with a total capacity of 5,000,000 gallons a day are maintained in the old pumping station ready for instant use.

The new generators have a capacity of 4,000 k.w. as against 1780-k.w. in the old plant. The new plant has a nominal boiler horsepower of 1536 that can be operated at 250% rating, while the old boilers probably could not exceed their nominal capacity of 1162 horsepower. All of the new units have higher efficiencies and the new boilers carry higher pressures.

Water is taken from Lake Ivanhoe through a 30-inch cast-iron pipe terminating 350 feet from shore in 22-feet depth of water in a 30-inch cross. The intake leads to a suction well in which are located separate suction pipes for the low-lift pumps and the circulating pumps connected to condensers. The suction well is 14 feet diameter with the bottom 11 feet below average lake level. The top of the 30-inch intake line is 5 feet below average lake level. Two sets of double screens protect the pump suction.

THE PURIFICATION PLANT

Four filters were constructed with a nominal capacity of 1,000,000 gallons each when operated at 2 gallons per square foot per minute. The old slow sand filters were remodelled into two uncovered coagulating basins by raising the walls 4 feet and installing baffle walls.

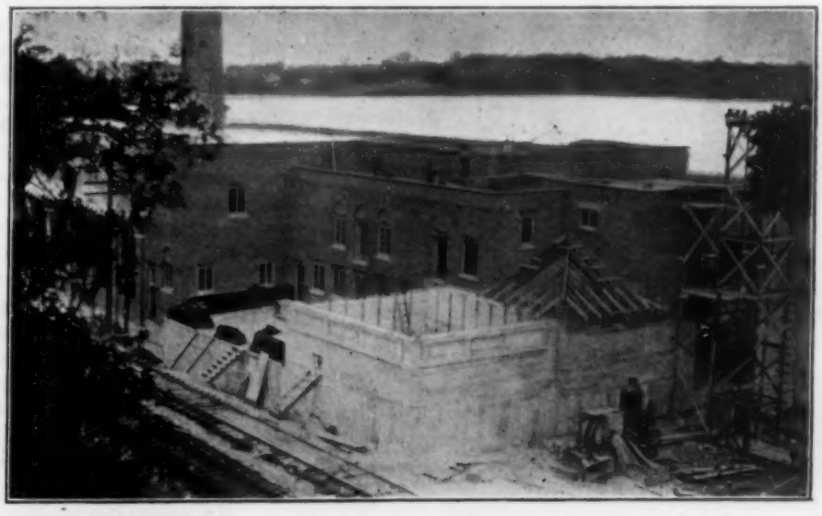
Water is pumped by the low-lift pumps to 16 aerating nozzles located over the mixing chamber at the rear of the plant. The object is to remove the odor and taste of algae which are abundant in all the lakes in this region, and to lower the Co_2 content. The mixing chamber, which is of the over and under type, provides an 18-minute mixing period at a 4,000,000-gallon rate.

Lime and alum are fed by dry-feed machines, which, like the filter equipment, were installed by the International Filter Company. Alum is applied to the first compartment of the mixing chamber and lime is applied after the water has passed through the first coagulating basin, to which it flows after passing the aerators and mixing chamber. The two coagulating basins may be used either in parallel or in series. The combined capacity of the two basins is 1½ million gallons, affording a 9-hour settling period at a 4,000,000-gallon rate. (The present average rate is 2,000,000 gallons.) This long settling period is used to effect as high a percentage of color removal as possible, this being the main purpose of the coagulating basin, since the turbidity is less than 20 parts per million.

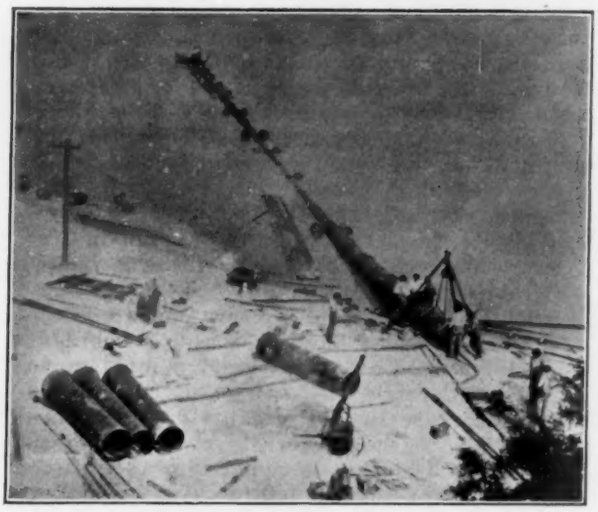
From the coagulating basins the water flows by gravity to a plant of four rapid filters. These contain manifolds and perforated laterals of cast-iron 2 inches diameter with ¼-inch holes spaced 6 inches on centers and pointed downward, the laterals also being spaced 6 inches. Controllers are of the Venturi type. Effluent pipes from the controllers turn down into the clear well. Chlorine is applied to the filtered water as it passes through a 5-foot wall opening on the way from the filter effluent to the pump suctions.

The clear well has a capacity of approximately 400,000 gallons at a depth of 9 feet. It is connected by a 16-inch pipe to the clear well at the old plant which has a capacity of 300,000 gallons. The suction of one of the high-lift pumps is connected to this 16-inch line so that this pump can draw from either clear well as desired. The other two high-lift pumps are connected to the new clear well only.

By means of this plant the color is reduced from 75 to 90 parts per million in the raw water to 10 or 15 parts per million; the alkalinity increases from 10 parts in the raw water to 35 or 40 parts in the filtered water, using methyl orange as an indicator; and the total hardness increases from 15 or 20 parts per million in the raw water to 40 or 45 in the filtered water. Most Florida cities have much harder water, from 300 to 1100 parts per million being common with underground supplies. One Florida city used water from a group of wells having a total hardness of 1800 p.p.m.



VIEW OF BUILDING FROM TOP OF WASH-WATER TANK.
Mixing chamber in foreground. Lake Ivanhoe in background.



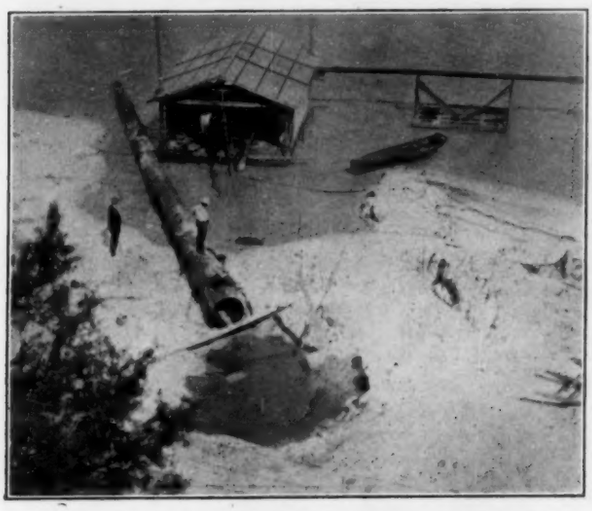
INTAKE ALMOST COMPLETED AND READY TO BE SUNK.

Two elevated tanks of 250,000 gallons each have been erected in the southern and eastern parts of the city considerably distant from the pumping station, and maintain a much more uniform pressure under varying rates of pumpage than prevailed before their construction.

CONSTRUCTION FEATURES

The construction equipment consisted of a concrete mixer with tower hoist, steam hoisting engine and tower for hoisting brick and mortar, and two small gasoline mixers for occasional use. Union labor from all sections of the country was available during the winter under open-shop conditions at 65 cents to $1 per hour for the building trades.

The most interesting feature of the construction was the installing of the intake. This was accomplished by floating the 30-inch cast-iron pipe to the location desired and sinking it there. In performing this work a launching plattform about 100 feet long and 6 feet wide was built of 2-inch lumber extending out into the lake about 50 feet. A 12x12-foot platform of large timbers and planking was constructed on the launching platform, to serve as a support on the lake bottom for the cross at the outer end of the intake line to prevent it from sinking into the soft material. This heavy platform was supported on rollers and the 30-inch cross was anchored to it by means of two sets of ½-inch round stay rods which passed through the platform and were bolted on the under side. Wooden bulkheads were caulked into the three openings of the cross, oakum being used to insure watertight joints. A steel cable with a float at the end was attached to each bulkhead so that it could be pulled out after the pipe had been placed in its final location. (This scheme did not work, however, as the wooden bulkhead had so swelled that it could not be removed in this way and was cut out by means of a diver.)



SHORE END OF INTAKE LINE BEING LOWERED TO GRADE BY DREDGING OUT SAND.

The 30-inch pipe was then joined to the cross, enough lengths being added to use all the available space on the launching platform. The line of pipe was then moved out into the lake and other joints added, and this was continued until the entire 350 feet of line had been connected up and was floating in the lake. The pipes rested on rollers and two sets of block and tackle were used to prevent them getting out of control and sliding prematurely into the lake. The shore end being higher than the floating section, it moved very easily.

Computations showed that the 30-inch pipe, which was Class A weight, required additional buoyancy to prevent sinking should any material amount of leakage occur at the bulkhead, and watertight barrels were used for pontoons, two to each two lengths of pipe. It was found that the bulkheads leaked slightly and the water was kept pumped out of the intake line by a trench pump having a wrought iron pipe connected to the end of the suction, additional lengths of wrought iron pipe being added as the intake lengthened.

When the terminal cross had reached the desired point, this pumping was stopped and the line allowed to fill up, and it sank to the bottom in 1½ hours. This left the shore end several feet above its permanent elevation, and a suction dredge removed the sand under the pipe until it had been lowered to the proper elevation, when it reversed the process and pumped sand back to cover the pipe. A bulkhead in the shore end of the pipe prevented sand from filling it during this process.

As stated, it was found impossible to draw the bulkheads from the cross, and one of the waterworks employees who had had previous experience as a diver cut out the three bulkheads in about a day, as well as removing the barrels which had been drawn down when the intake line settled.

The cost of this work was less per foot than laying the same size pipe in a trench under ordinary conditions. The work was completed

without an accident under the superintendence of E. M. Austin, waterworks superintendent for the Orlando Utilities Commission.

CLEANING THE MAINS

An examination of the distribution system showed that the pipes were very badly encrusted, some 4 and 6-inch pipes having such small openings that it was barely possible to pass sewer rods through them. Tests showed that the average carrying capacity of the distribution system was only 30% of that given by Weston's tables for pipe of the same age. Some cleaning had been done in the past, but a general cleaning of the whole system had never been attempted, and it was decided to clean all mains except one 16-inch line which had been in use only a short time.

The cleaning was done by the National Water Main Cleaning Company, approximately 20 miles of 4-inch to 12-inch mains being cleaned. This increased the capacity of the system approximately 50% with resulting increase in pressures. The cost average 10.33 cents per foot, 8 cents of which was the contract price paid the company and the balance was the cost of labor supplied by the city.

The old utility company had maintained a pressure of 25 pounds per square inch in the center of the city, which was increased at times of fire. When the city took over the plants it increased this to 35 pounds and since the new plants have been put into regular operation the pressure has been maintained at 60 to 65 pounds. As the city is comparatively level and pumpers are used for fire-fighting, higher pressure did not seem to be justified.

EFFICIENCY

The new plant has proved very economical in operation, the greatest economy in connection with the new boilers and generators being the use of oil. The saving in fuel alone is sufficient to pay approximately 10% interest on the investment in the new plant.

The operating force consists of one operator who is in charge of the plant during his shift and is responsible for the continuity of service of both electric and filtration plants; an oiler who washes the filters, watches the dry feed machines and keeps the hoppers filled with dry coagulant; and a fireman. The whole plant is in charge of the chief engineer, with mechanics, boiler washers and laborers as needed.

The plant is under the administration of the Orlando Utilities Commission, a board of five members constituted by act of legislature. The first commission was appointed by the Mayor and consisted of the presidents of the four banks and of the Building and Loan Association. The success of this municipal plant is due in no small measure to the efforts of this first commission who assisted very materially in financing the plant to its completion. The construction of the plant and the installation of equipment were under the supervision of the writer, representing the consulting engineers.

Lime in Sewage Treatment*

Investigation by Maryland Bureau of Sanitary Engineering. Conclusions from field observations and laboratory studies.

By T. C. Schaetzle†

TREATMENT WITH FERROUS SULPHATE

As stated, the lime-treated sludge appeared to lose the mechanically entrained water very slowly. In order to ascertain more definitely the amount of water which can be removed by filtration per unit of time and to learn if the addition of some chemical would hasten the rate of filtration, a series of laboratory experiments were conducted. It was determined that ferrous sulphate would be the best chemical to use since iron, in certain proportions, should be a helpful element in a fertilizer; whereas aluminum sulphate, because of its acid properties, might be objectionable. Preliminary experiments were conducted, therefore, using a ferrous sulphate solution. These experiments indicated that the ferrous sulphate lime-treated sludge would give up its water more readily than the lime-treated sludge alone, but as this may have been due, in part at least, to the water in the ferrous sulphate solution, it was determined to conduct additional experiments with ferrous sulphate in salt form.

As the Hagerstown Sewage Treatment Works is designed to treat 3,000,000 gallons of sewage daily, 3,600 gallons of sludge should be produced each day, if the rate of deposition of solids continues at the same rate as at present. On this basis, it was decided to experiment with such quantities of ferrous sulphate as would not exceed those amounts which would make the treatment economically feasible. Considering the present market value of iron sulphate at about fifteen dollars per ton, it would seem that 2,400 pounds of this chemical could be used per day. The experiments were conducted, therefore, with amounts of ferrous sulphate ranging from 600 to 2,400 pounds per day, which is equivalent to 62, 124 and 248 grains per gallon.

The experiments conducted were divided into three sections—

1—To determine the separation of liquid from sludge during a quiescent period.

2—To determine the rate of filtration of the sludge with varying dosages of ferrous sulphate.

3—To determine the turbidity, hydrogen ion value and odor of the filtrates.

The results of a part of these investigations are presented in figures 1 to 3. It was noted that, even after an 18-hour quiescent period, no supernatant liquid appeared upon the top of the

*Concluded from page 172.

†Senior Assistant Sanitary Engineer, Maryland Bureau of Sanitary Engineering.

ferous sulphate lime-treated sludge, but that a small quantity of liquid amounting to 6 percent of the original volume of sludge came to the surface on the sludge treated with lime alone. It was found further, that a considerably greater portion of water separated from the raw sludge than from any of the sludges treated either with lime or lime plus ferrous sulphate. This raw sludge liquor was acid in reaction, having a 5.4 pH value as against the values of 8.5 to 8.8 for the treated sludges. The color of the filtrates was changed from a brown to a yellow at a pH value of about 8.6 and the odor of all the filtrates was one of lime with the intensities practically the same.

Thorough mixtures of lime-treated sludge with ferrous sulphate dosages ranging from 62 to 248 grains per gallon were thrown upon coarse-grained filter papers and filtration allowed to take place for about three hours. A coarse filter paper was selected so as to approach the porosity of a sand filter as closely as possible. It will be noted on figure 1 that the treatment of the lime sludge with ferrous sulphate increases the rate of filtration and quantity of filtrate and that, in all cases, the major portion of the liquor separates from the sludge in thirty minutes. There is a slight increase in the quantity of filtrate during the next thirty minutes, after which filtration ceases. The rate of filtration of the sludge treated with lime alone is considerably less than that of the ferrous sulphate treated sludge. Although not shown by figure 1, the quantity of filtrate from the limed sludge does not equal that of the iron-treated material, even after several hours.

Due to the color of the filtrates from the sludges shown on figure 1, their turbities could not be determined with the regular turbidity standards. The determinations were made, therefore, by using, a 50 c.c. Nessler tube with the bottom of it in contact with a paper upon which several x's were typewritten. The various filtrates were then poured into the Nessler tube until the x's just disappeared. The depth of liquid used and designated as the "vision depth" is plotted in inches as ordinate on figure 3 against the constant diameter of the Nessler tube as abscissa. These figures indicated that the sludge treated with 124 grains per gallon of ferrous sulphate produced the clearest filtrate with a pH value of 8.8. Upon the addition of twice this quantity of ferrous sulphate, the pH value fell to less than 7.2 and the filtrate became very turbid, indicating that the iso-electric point was probably at 8.8. It was decided, therefore, to determine the effect of heating a mixture of lime-treated sludge and 124 grains per gallon of ferrous sulphate upon the quantity of filtrate or its rate of filtration or both. A portion of this sludge was heated, therefore, to 35°C. and filtered. Figure 2 shows the results and indicates clearly that most of the filtrate is obtained in 30 minutes, whether filtration takes place at room temperature or at the higher temperature, but that there is a materially greater quantity of filtrate obtained upon heating, although the pH value was raised to only 8.9. The turbidity of the filtrate from the heated sludge is less than that of the cold sludge, as shown by figure 3.

CHEMICAL ANALYSES

Alhough not a part of this particular investigation, it seemed advisable to learn something of the fertilizer value of the lime-treated sludge

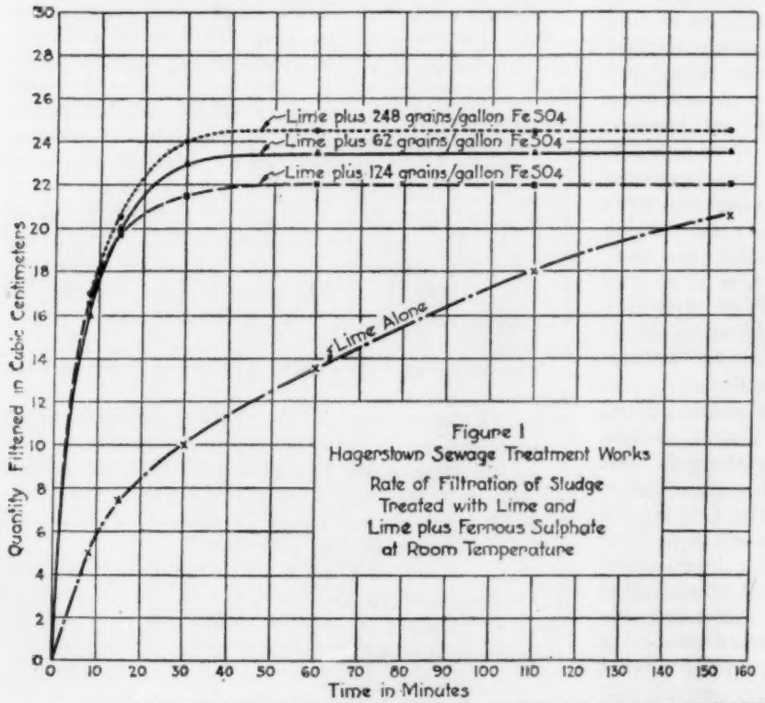
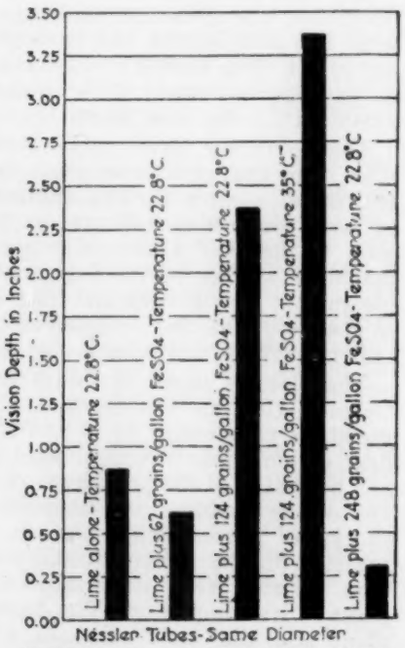


FIG. 1—SLUDGE TREATED WITH LIME, AND LIME PLUS FERROUS SULPHATE, AT ROOM TEMPERATURE.


Vision Depth in Inches
Lime alone - Temperature 22.8°C.
Lime plus 62 grains/gallon FeSO4 - Temperature 22.8°C.
Lime plus 124 grains/gallon FeSO4 - Temperature 22.8°C.
Lime plus 124 grains/gallon FeSO4 - Temperature 35°C.
Lime plus 248 grains/gallon FeSO4 - Temperature 22.8°C.
Nessler Tubes-Same Diameter

TURBIDITY VALUES FOR SLUDGE TREATED WITH LIME AND LIME PLUS FERROUS SULPHATE.

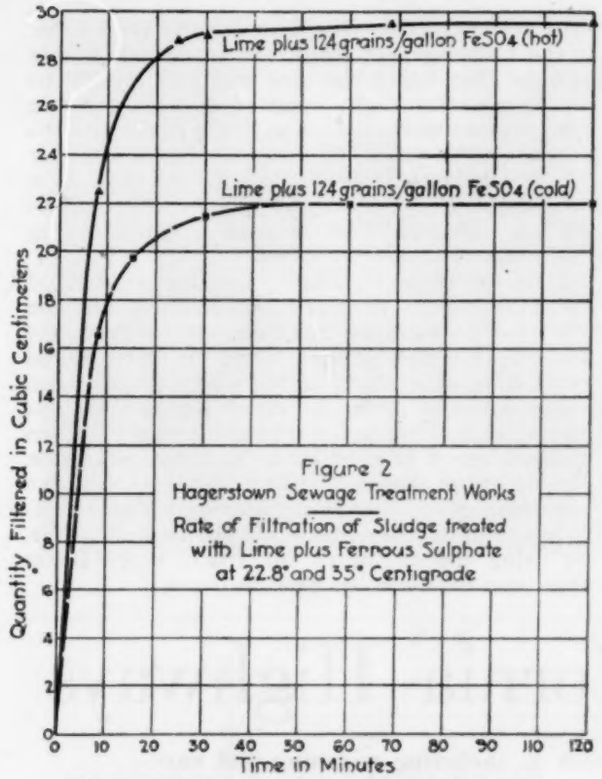

Lime plus 124 grains/gallon FeSO4 (hot)
Lime plus 124 grains/gallon FeSO4 (cold)
Quantity Filtered in Cubic Centimeters
Time in Minutes
0 10 20 30 40 50 60 70 80 90 110 120
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Figure 2
Hagerstown Sewage Treatment Works
Rate of Filtration of Sludge treated with Lime plus Ferrous Sulphate at 22.8° and 35° Centigrade

FIG. 2—SLUDGE TREATED WITH LIME AND FERROUS SULPHATE AT 22.8° and 35° C.

as compared with the raw sludge. It was noted that lime treatment did not immediately affect the nitrogen content of the sludge. A loss in nitrogen, however, through storage of the lime-treated sludge upon the sand beds did occur. This may be due to some chemical change liberating the nitrogen as free ammonia, which reaction is indicated by the development of an ammonia odor in the sludge samples held for observation in this office.

CONCLUSIONS

From the field observations and the laboratory studies, the writer is of the opinion that the odors emanating from lime-treated sludge should be less disagreeable than those from raw sludge. It should be borne in mind, however, that the sensitiveness of the olfactory nerves varies with different individuals and that for this reason a limey odor may be as objectionable or even more so than the original sludge odor to some people. It should be stated, however, that after the lime-treated sludge had been applied to the ground, the writer was unable to discern any odor similar to that coming from raw sludge. Furthermore, he does not believe that the intensity of the odor from the lime-treated sludge or its carrying power is sufficient to cause annoyance at an appreciable distance from the plant or its point of application to the ground. There should be no change in the type or intensity of odor from that which is present immediately after lime treatment. This is probably due to the fact that sufficient lime is added to bring about immediate partial sterility and that prolonged storage further reduces the bacteria so that they are unable to multiply in sufficient quantities to bring about putrefaction.

It is evident from field observations and laboratory experiments that the lime-treated sludge holds its water more tenaciously than the raw material and that, when applied to the sand beds, becomes a pasty mass and will require a considerable period of time before it will dry to a point where its moisture content lies between 65 and 70 percent. The drying of the lime-treated sludge which does take place is due primarily to evaporation and, therefore, the period of time required for drying any batch of this sludge is more directly related to weather conditions than is the case when drying digested sewage sludge. It is difficult to estimate the drying period required but the data obtained indicate the need for at least one month storage on sand beds.

It is evident that ferrous sulphate will be helpful in causing the sludge to drain more freely and that an application of 124 grains per gallon, which is equivalent to 600 pounds per day at the present rate of sludge production, is the most feasible and economical rate of application. Heating the sludge after treatment with ferous sulphate should be helpful. Whether these facts would have a definite bearing upon the rate of filtration through a sand bed is problematical because of the short period of time elapsing before filtration ceases, but it probably would be helpful if centrifuging or pressing should be resorted to.

Since the investigation considered plain sedimentation sludge only, further experiments will be conducted with the activated sludge when the Peck aerator is in operation.

Gravel Roads in Iowa

On January 1st, 1925, the primary road system of Iowa contained 6,660 miles, of which only 502 miles were paved and 2,164 had a gravel surface; while 1,934 miles had been given permanent grade. The combined paved and gravel roads constituted about 40 per cent. of the entire system, and 30 per cent. were ordinary earth roads which had not even been permanently graded.

In addition to the mileage of gravel road in the primary system, there were 2058 miles of gravel county roads, but only 2 miles of county roads had been paved. The total mileage of county roads is 11,180.

Last year's work included 354 miles of gravel surfacing in the primary system and 355 miles in the county system.

Maintenance expenditure for earth roads last year averaged $339 on the primary system and $222 on the county roads. Maintenance of gravel roads in the primary system averaged $531, and $264 in the county system.

The construction of primary gravel roads cost an average of $2,188 per mile, this including the cost of the gravel, transportation, dumping and

spreading. On county roads the gravel construction averaged $1,596. The difference in cost is partly because of the greater amount of gravel used on the primary roads and the fact that not so much care was taken to secure a good class of gravel for the township roads.

Constructing the hard-surfaced roads cost an average of $31,481 per mile, about 60 per cent. of these being 18-ft. pavement and about 40 per cent 20-ft. pavement. The maintenance of the 502 miles of hard-surface roads cost an average of $146 per mile.

Waterworks Maintenance in Springfield

In his report for the year 1924, Howard M. King, Superintendent of Waterworks of Springfield, Mass., in telling in detail of the functioning of the department during the year, stated that, "Owing to the considerably increasing trouble caused by the filling up of service pipes, it was decided this year to line the inside of pipe with cement. This was done by our own force at the Colton street plant. It seems reasonable to hope that lining the pipe will add greatly to its usefulness. Eight hundred and twenty five service pipes were cleaned with the Staples cleaner during the year. This is simply a temporary job which lasts from one to three years as a rule, when the service again fills up. This cleaning has postponed for the time being replacing this number of service pipes.

"The department bought an Ingersoll-Rand Air Compressor mounted on a Ford one-ton truck This machine has been of the greatest use. It is mobile, compact and an efficient and great time saver in breaking up concrete, frost, ledge, etc. It probably saved its cost on one street where we put a trench through brown stone ledge where blasting was not advisable. The department also bought a Payne-Dean valve operating device that is installed on the emergency car. This device will operate our largest valves, by using the engine of the truck, much faster than can be done by hand."

Rebuilding California Highways

Two reconstruction projects in Division X, including widening and surfacing with asphaltic concrete and construction of shoulders of a new type. Spreader box designed by contractor.

By J. C. McLeod*

Two important projects that mark a departure from former reconstruction practices in California were completed last winter in Division X of the California State highways. Both of these involved the use of asphaltic concrete for widening and surfacing, and included construction of shoulders. The shoulder work was of particular interest as it was the first test of this particular type of reconstruction in California.

*Division Engineer, California State Highway Dept.

SPREADING ASPHALTIC CONCRETE BASE, USING SPREADER BOX.

THE SOLANO PROJECT

One of these projects is in Solano County between Vacaville and Batavia. This was an old fifteen-foot concrete slab forming a part of the trunk highway leading from these cities to Sacramento, with a total length of 8.3 miles. Due to the adobe soil sub-base on portions of this section, the existing concrete pavement, which had been placed in 1916, was rough and was rapidly becoming a serious maintenance problem. It was also too narrow to adequately handle the existing traffic and it was thought necessary to widen it to twenty feet and at the same time to thicken it. Also opportunity of the reconstruction was taken to correct the alignment and to widen and super-elevate curves with a minimum radius of 500 feet. As there was no super-elevation of the old pavement, the outer sides of the grade were built up with new loam and crushed rock, which was thoroughly wetted and rolled before the new pavement was placed. Also as the crown of the

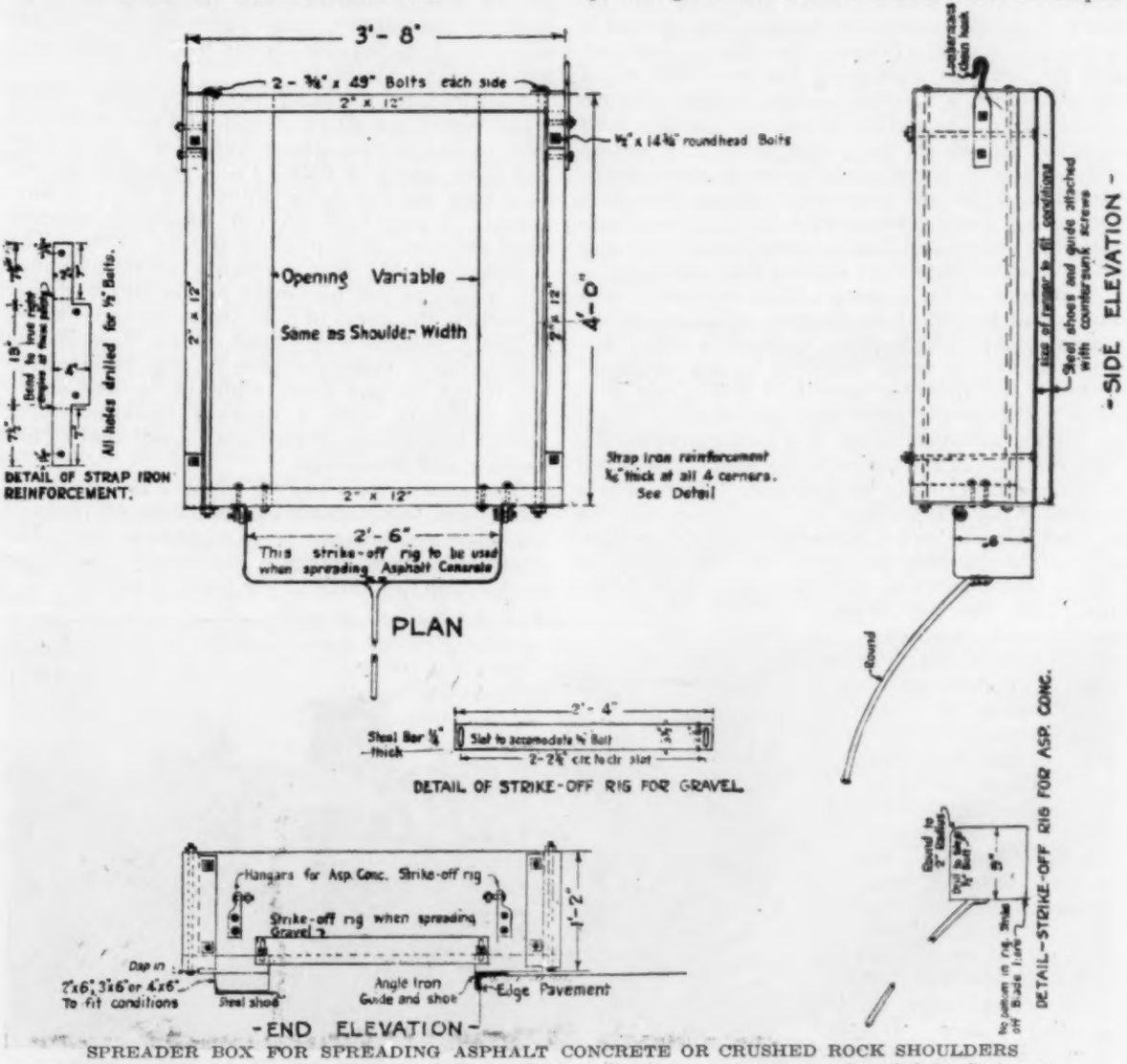
SPREADING ROCK SHOULDERS.

old cross-section was greater than desirable for the new pavement, opportunity was taken to flatten it.

The first two thousand feet immediately east of the city limits of Vacaville was improved with a second story concrete construction twenty feet wide with nine-inch edges, the edges being reinforced. This type of pavement was used where the highway crosses a low spot. The remainder of the widening was done entirely with asphalt.

For widening the subgrade, new earth was hauled in from approved borrow pits furnished by the state. The loam soil thus obtained has proved preferable as a sub-base to the adobe soil.

Paving operations began with the trenching out of the earth shoulders on each side of the concrete slab to a width of 2½ feet and to about the depth of the existing pavement. Outside header boards were then set to a true grade, regardless of the irregularities of the old pavement. The trench was then filled with asphaltic concrete base mixture which was thoroughly compacted. For spreading this base mix the contractor developed


3'- 8"
2 - ⅞" x 49" Bolts each side
2" x 12"
½" x 14½" roundhead Bolts
Opening Variable
Same as Shoulder Width
4'-0"
2" x 12"
2" x 12"
Strap iron reinforcement ⅛" thick at all 4 corners. See Detail
2'- 6"
This strike-off rig to be used when spreading Asphalt Concrete
PLAN
DETAIL OF STRAP IRON REINFORCEMENT.
All holes drilled for ½" Bolts.
Bend to have ends in these planes
Lanterns (chain hook)
Seal shoes and guide attached with countersunk screws
Use of runner is to fit conditions
SIDE ELEVATION
Round
2'- 4"
Steel Bar ¼" thick
Slot to accomodate ¾ Bolt
2-2½" ctr to ctr slot
DETAIL OF STRIKE-OFF RIG FOR GRAVEL
Hangars for Asp. Conc. Strike-off rig
Strike-off rig when spreading Gravel
1'-2"
Dap in
2"x6", 3"x6" or 4"x6" To fit conditions
Steel shoe
Angle Iron Guide and shoe
Edge Pavement
END ELEVATION
Bend to 3" Radius
5"
DETAIL-STRIKE-OFF RIG FOR ASP. CONC.

SPREADER BOX FOR SPREADING ASPHALT CONCRETE OR CRUSHED ROCK SHOULDERS

Designed, constructed and used successfully by Force & Currigan, contractors, and copied for State use through their courtesy.

PLACING TOP COURSE, USING MECHANICAL SPREADER.

spreader boxes which receive the base mix directly from the trucks and mechanically placed it in the trench with a proper allowance for compaction by rolling. Following the construction of the shoulders, a leveling course of base mixture was laid for the entire twenty-foot width thus secured, by which were eliminated the excess transverse crown and also the longitudinal irregularities of the old pavement. After this base course had been compacted a 1½-inch top mixture was placed and finally a hot asphalt seal coat and hot screenings were applied and rolled in.

A feature of the placing of the top course was the use of two steel mechanical spreaders of the Galion make, which were operated a short distance apart. A lever attached to the strike-off plate of the spreader permitted the operator to raise or lower the plate and thus deposit larger or smaller amounts of the mix as required by the irregularities of the old concrete slab. The result was an exceptionally smooth job. There was a minimum of separation of aggregates in the asphalt mixture and it was also evident that there was a considerable saving to the contractor, as three rakers and four shovelers were able to handle, with the aid of the mechanical spreaders, a plant output that ran as high as 400 tons per day.

Following the construction of the pavement, 2-foot crushed rock shoulders were placed on each side along the completed pavement. The contractor worked out a wooden spreader box for spreading the crushed rock or gravel over these shoulders and secured a very uniform distribution of the material.

The total cost of the grading, new drainage structures and pavement widening and thickening of this job was approximately $242,500 for 8.3 miles. The contractors were Force and Currigan, who made special efforts to complete the job promptly under unfavorable weather conditions, starting paving on August 16th and finishing the contract on January 14th. H. O. Ragan was resident engineer in charge for the state.

THE SAN JOAQUIN PROJECT

The other reconstruction job was in San Joaquin County between a point two miles east of Tracy and the Alameda County line, being 8.1 miles long. This was similar to the work described above, except that the road improved was a fourteen-foot oil macadam road built by the county many years ago and which had proved inadequate for the present traffic and expensive to maintain.

Anticipating its early reconstruction, 6-inch water-bound macadam shoulders 4 feet wide had been placed on this section during the fall of 1923 and early spring of 1924. These shoulders served as a base for the outer portion of the new surfacing. A total of 24,470 tons of asphalt mixture were required for surfacing the 8.1 miles. The thickness of the new surfacing averaged about 2½ inches at the pavement center line and had a uniform thickness of 5 inches at the outer edge.

The pavement was placed in two courses, the first being a leveling course to remove inequalities in the old pavement, while the second was a top surfacing with a uniform thickness of 2 inches, which was covered with a seal coat of hot asphalt and screenings.

The contractor's paving plant was located at Tracy and was capable of producing 400 tons of asphaltic concrete mix in an eight-hour day. The contractor used modern equipment, including mechanical spreaders of the roller type.

TWO SPREADERS OPERATING TOGETHER IN PLACING SURFACE MIXTURE.

Gravel shoulders were placed along the edges of the new pavement and thoroughly compacted and have been commented on very favorably. They serve as a protection to the pavement edge and an added safety factor in that they prevent the tracking of treacherous adobe soil across the highway.

The contract was awarded to the Valley Paving Company in July of last year and was completed January 3rd of this year. C. O. Dingle was resident engineer.

The cost of this work, including the widening of the grade to state highway standards, was approximately $194,000. San Joaquin County has many miles of oil macadam highway built by the county, which must be widened and thickened before the state highway system within the county can be considered completed.

Winter Use of Highway Maintenance Force

The annual report of the Rhode Island Board of Public Roads says:

"As the fiscal year closed, our maintenance forces had been reduced to the minimum manpower which we have found it necessary to carry through the winter as a nucleus to carry out our snow-removal program. These men are kept busy during the winter months between periods of snow removal in placing temporary patches over cuts made in our hard-surfaced roads during the winter by public utilities, the patching of holes in our cheaper roads, the cutting of brush along the roadsides, the painting of guard railing, the repair of equipment and the hauling and storing of materials for future maintenance. The effective use made of these few maintenance men whom it is necessary to keep in our employ throughout the winter if we are to carry out successfully our program of snow removal makes the cost of snow removal comparatively low."

Cost of Maintaining Rhode Island Roads

The cost of maintaining bituminous concrete (coarse aggregate) roads in Rhode Island in 1924 averaged 7.3 cents per square yard of road in service, varying on the different roads from 33.9 cents to 0.4 cents. Maintaining bituminous concrete (graded aggregate) averaged 0.6 cents, varying from 7.0 to 0.1 cents. Maintaining bituminous macadam averaged 2.2 cents, varying from 19.1 to 0.1 cents. Maintaining bituminous surface on concrete base averaged 0.3 cent, varying from 0.8 cent to nothing. Maintaining cement concrete averaged 0.4 cent, varying from 2.6 cent to nothing.

These figures are of course misleading unless the age of the pavements, traffic carried, etc., are known also. As to the age, the average age of the coarse aggregate bituminous concrete was 13 years, that of the graded aggregate bituminous concrete 4 years; bituminous macadam, 5 years; bituminous surface on concrete base, 4; and cement concrete, 2 years.

Combining these figures we have:

Kind of surface	Age	Maintenance Cost per sq. yd.
Bituminous concrete, coarse ag....	13	7.3 cts.
Bituminous concrete, graded ag....	4	0.6 cts.
Bituminous macadam	5	2.2 cts.
Bituminous surface on concrete base	4	0.3 cts.
Cement concrete	2	0.4 cts.

Indiana Sewer Construction

In his report for 1924 the Mayor of Evansville, Indiana, reports difficulty in letting contracts for sewer construction in that city because of certain state laws. The Board of Public Works advertised a sewer job last year for which not a single bid was received. In explanation of this he said: "It seems that the objection of contractors was the Indiana law under which sewers are built. This law makes it impossible for the contractor to collect any money for his work until about thirty days after the assessment roll on the entire job is approved and accepted."

Dating Concrete Pavements

The California State Highway Commission's specifications for concrete pavement now require contractors to stamp the date and name of the builder of the pavement at the point of beginning and ending each day's run. This permits anyone to learn the name of the builder of any stretch of pavement and highway officials to quickly and definitely identify any given stretch of pavement concerning which they wish to learn the history.

Suspension Bridge to Facilitate Construction

The California Highway Commission, in order to provide means for transporting construction materials across the Merced river at Briceburg, Mariposa county, from the railroad which lies on one side of the river to the highway which is being constructed on the opposite side, has erected a suspension bridge 161 feet long with a roadway width of only 9 feet and with strength sufficient to carry safely 10-ton trucks. The cost of the bridge was approximately $8,000.

CONSTRUCTION BRIDGE BUILT BY CALIFORNIA HIGHWAY COMMISSION

Making Rochester's Assessment Maps

Method employed by Bureau of City Map and Survey of the Department of Engineering. Collecting data, field work, and preparing maps for various city departments. Geodetic control.

There are approximately 33 square miles of land included within the corporate limits of Rochester, N. Y. About 11 square miles of this was surveyed many years ago by John C. Ryan and the remainder has been added from time to time, each addition being surveyed by itself generally regardless of the others.

Recently it was proposed to install a new system of assessment, and this brought to a head the necessity which had already been felt for assessment maps which are up-to-date, drawn to uniform size and scale and of known accuracy. This work was turned over to the Bureau of City Map and Survey of the Department of Engineering of the city, and the method of performing the work has been described as follows by Hirman E. Bryan, of that bureau, in the "Rochester Engineer".

Preparing assessments maps covering the entire city involves the drawing of over thirteen hundred maps at a scale of one inch equaling fifty feet. It is the intention to show on these maps each parcel of land in the city. These maps are drawn on sheets twenty-one inches by thirty inches. The city is divided into thirty-three districts. The districts were not designed to follow ward boundary lines as, after careful study, it was found that ward boundaries changed often, whereas the arbitrary lines establishing these districts will probably be maintained until somebody else has a new system of assessment to install. This plan of districting is followed out in other cities where ward lines are more or less disregarded. These divisions are usually called "Tax Districts." In numbering these districts it was thought advisable to designate the districts lying on the west side of the river with odd numbers and those on the east side with even numbers, so that the location of a district was determinable at once by the odd or even numbers. The maps are then numbered in each district. Each map is planned to include, whereever possible, a certain number of blocks. The blocks are also numbered on each map. Further, the parcels in the block are numbered so that the identification number of any piece of property in the city consists of a combination of the district, map, block and parcel number, and it is the intention to identify property when this set of maps is completed by this identification number. Under this method, no duplication of numbers is possible. If property is further divided, modification of the identification numbers can be made by the decimal system.

In the preparation of this first set of assessment maps all the existing data and sources of information are considered. These include the original survey of the city and surveys of the several additions made from time to time; also the miscellaneous surveys and locations made by the Bureau of Surveys at various times that pertain to the location or relocation of streets and property. All this information is reduced onto maps of a standard size and scale, as specified above.

The second phase of the work is the necessary field work to tie together all of these various surveys and maps, including any necessary additional work so that the first phase can be completed, and simultaneously doing as much as possible on the re-running of lines and the re-establishing of lost corners so that when the third phase is begun a considerable portion of the field work will have been accomplished.

The third phase of the work is the conversion of the assessment maps into survey maps so that the city departments and the public can be supplied with adequate maps for any purpose. All the necessary information for the relocation or re-establishing of the lines of any parcel of property in the city will be shown, together with complete block distances, corner angles and any other survey information. An attempt will be made to reconcile any existing surplus or shortage in the blocks. The legal status of this will be the same as it is in the case of the Ryan maps. However, it is the intention to maintain these maps to date at all times and whenever a disputed line is settled differently than shown on these maps, the changes will be made immediately, and any division or subdivision of property made after the completion of these maps will be shown as they occur; so that at all times the city will have a set of maps showing property as it actually exists.

The field notes for this work are made in duplicate and the duplicate sheets are perforated so that when removed from the field note book they are of lefax size. Further, the calculations are also on sheets of double lefax size and the deed forms on which the transcripts are typewritten are of the same size, so that on the completion of each map the transcripts of the deeds, the calculations, and the field notes for each map are combined and put in a binder and labelled with the district and map number, so that any information concerning any particular map can be found in the book covering that map. A title card for each piece of property showing

ownership and reference to source of title is also made for each parcel on each map.

The fourth phase of the work is the Goedetic Control. Through the cordial cooperation of the United States Coast and Goedetic Survey, the staff of that office, in the spring, will measure a forty mile circumferential base with two or three possible cross lines connecting one side with the other. All these measurements are base measurements and the work will probably be in charge of Lieutenant E. O. Heaton, who has recently completed some base line measurements in California for a redetermination on the speed of light.

At least two cross lines will be run conecting the eastern and western boundaries of the circuit. This will divide the area included by the circuit in three parts, and a division north and south is under consideration which would divide the entire area into six parts. Further, the Coast and Geodetic Survey intends to carry in the primary triangulation from some of the stations outside of the city and establish approximately thirty new stations scattered throughout the entire city so that there will be an opportunity to connect the city survey with these points in every section where work is being done, and any errors can be reconciled between two known points.

The personnel of the Bureau is divided into three sections; the Drafting Section, under the direction of George R. Herschell; the Field Section, under the direction of S. A. Corkhill; and the Title Work, under the direction of Miss Bertha E. Ballard. In connection with this work the Department of Assessment has employed a draftsman who is working under the supervision of this bureau, preparing copies of all subdivision maps filed in the County Clerk's office. These maps are to be indexed in the City Assessor's office in the same way that the city map is divided, so that any subdivision occurring in the district may be found in the book of Subdivision Maps for that district.

There are many peculiar, some of them humorous, incidents in connection with the title work and several stories could be written on this phase alone. As a matter of passing interest, the title to some of the most expensive downtown property is so indefinite from a survey standpoint that one wonders how any lawyer would dare commit himself in passing it. Further, the matter of unrecorded deeds causes no little annoyance. The conveyance of a thirty foot strip in an expensive residential section has just been recorded, although the deed was made out in 1897. Another case— we find title to property belonging to two wives of the same man; however, on further examination one of them was found to be dead.

Pavement Cuts in New Brighton

New Brighton, Pa., with a population of 10,000 has nine miles of paved streets. Last year, according to H. Wohlwend, engineer of the borough, the cost of repairing these was $3,699, at least 90% of which could be traced directly to the settling of the brick pavement one or more years after a cut had been made there.

During cold weather while the ground is frozen, the gas company makes a practice of testing for leaks, which is done by removing one or more brick and driving a bar through the frozen ground to let the gas escape. If no leak is found, the brick is replaced but usually the drilled hole is not filled, and in time the ground settles around it, a heavy truck pushes the brick down into the depression and the beginning of a bad place in the street is made.

The brick streets in New Brighton are laid on a gravel base. It has been the practice, where cuts are made through these pavements, to place on top of the trench a 6" concrete slab, one foot wider than the excavation, as a foundation for repaving. This gave good service for a while, but the earth beneath the slab has settled in many places and the slab tilted out of level, causing a bad hole.

Quick-hardening Pavement in Rhode Island

In its annual report for 1924 the State Board of Public Roads of Rhode Island describes a test made of the use of quick-hardening cement for certain road work. From the report we quote as follows:

"In order to obtain first-hand data on the use of quick hardening cement in the construction of cement concrete pavements, the department late in the fall as an experiment, constructed a stretch of reinforced cement concrete pavement approximately 300 feet in length, in which a quick hardening cement was used instead of Portland cement. The location selected for the experiment was the easterly approach to the Stone Bridge in Tiverton. This bridge approach is at the southerly end of Federal Aid Project No. 21, which was under construction and which extended from the Stone Bridge northerly for two miles on the road to Fall River. The traffic over this road is very heavy and we considered it a logical location to try out a quick hardening cement, the use of which would permit the pavement to be opened within a short period after laying.

"In general design the experimental section did not vary from the standard pavement constructed on the rest of the project except that the width was varied in order to meet the existing car tracks and curbs. The depth of the pavement was uniformly 8 inches. Expansion joints were constructed at the P. C.'s and P. T.'s of curves and at intervals of 125 feet on tangents. The reinforcement in the pavement consisted of electrically welded fabric weighing 65 pounds per 100 square feet and was placed 2 inches from the top of the pavement. Corner bars were used at the corners, ½-inch dowels used at the transverse joints and ½-inch tie rods used along

the longitudinal joint. The sub-base on which the pavement was laid was of gravelly nature and no other foundations were provided.

"The mixing proportions were 1:2:3 by volume. The quick-hardening cement used is known as Atlas Lumnite Cement. The fine aggregate was Long Island sand and the coarse aggregate a mixture of Connecticut trap rock and local screened gravel. These materials were loaded in 5-bag-batch compartments on 5-ton trucks and delivered to the paver. The cement was dumped by hand into the mixer skip. After mixing in the drum a minute, the resulting concrete was deposited by boom and bucket onto the sub-base, was struck off by a steel shod 200-pound screed, and, after being touched up by a hand float, was belted and broomed.

"Up to this point the process of mixing and placing this quick-hardening cement concrete was no different from Portland cement concrete except for the fact that the mixture was much wetter, having a slump varying between 5 and 7. The curing of the pavement, however, was radically different from the customary procedure on a Portland cement job. On the first part laid wetting commenced about 3½ hours after pouring, at which time the surface had hardened sufficiently to withstand washing. A few checks and hair cracks developed about 30 minutes after the brooming. To prevent the checking the wetting period was advanced and water was applied immediately after brooming. At first some washing of the surface occurred, but by using a garden hose nozzle a fine spray was obtained which apparently did not affect the surface texture.

"The wetting was continued for 8 hours and no hair cracks, transverse cracks or excess shrinkage was noticed during the first 24 hours. One transverse crack on a narrow section between a point of angle in the curbing and the electric car rail developed later. This crack probably would have been avoided had a transverse joint been placed at this location as called for. The pavement was opened to travel 40 hours after pouring.

"As the work was in the nature of an experiment, mixing and placing records were kept by the department and parallel temperature observations made of the interior of the slab and the atmosphere in addition to the regular tests on the cement and the aggregate. Slump tests were made at three stations, with the following results:

Station:	3530-R	3660-R	3750-R
Slump:	6½"	5"	6"

"One noticeable thing about this particular cement concrete was that in spite of a slump between 5 inches and 6½ inches the consistency of the mixture was good and there was no noticeable segregation of the aggregate in the batches under observation. The mix appeared fat and was easily workable but did not show any great amount of excess water during the finishing process nor did any particular skim or laitance show before the brooming.

"Two sets of 6x12-inch cylinders were cast, three to a set, and gave the results noted below. The first set was cast in standard steel molds having machined steel plates on the ends. The second set was cast in chip board molds.

CYLINDERS

Station.	Slump.	Time of Making	Break—Pounds per Sq.In. 24 hr.	10 day.	28 day.
3660-R	5"	10:45 A. M.	3935	4950	7330
3750-R	6"	2:05 P. M.	3780	4120	4270

"The excellent breaks on but 24-hour curing are higher than any 28-day breaks that we have had as yet on Portland cement concrete.

"No abrasion of the surface of the pavement was noted on this section when opened to all traffic in 40 hours, even when this traffic included a 21-E Rex Paver and the contractor's heavy truck equipment. These results would indicate that when this cement is used the pavement may safely be opened in 36 hours.

"The placing and finishing time record which follows seems to indicate that there is no more difficulty in finishing Lumnite than Portland cement concrete. The necessity for immediate curing has been noted before.

	Station.	Laid.	Screeded.	Belted.	Broomed.
Oct. 27, 1924	3530-R	9:40	9:45	10:30	11:25
	3650-R	10:45	10:50	11:15	12:30
	3750-R	12:45	12:50	1:15	2:00
Oct. 29, 1924	3666-L	7:45	7:55	8:10	10:05
	3750-L	8:55	9:00	9:45	10:25

"Probably the most interesting test made was the parallel temperature test. An ordinary house thermometer was used for the air record while a Tycos reading to 300 degrees was placed in the slab and read every 30 minutes. The first set of readings were taken until the pavement showed no increase in internal heat, but the second set of readings were carried beyond to determine if possible the period during which this internal heat would protect the pavement from freezing weather.

TEMPERATURE RECORD

Set No. 1 (Station 3530-R) Time.	Temperature. Air.	Pavmt.	Hrs.	Set No. 2 (Station 3670-L) Time.	Temperature. Air.	Pavmt.	Hrs.
9:45 A. M.	44	58	0	8:00 A. M.	40	54	0
10:15	46	60	½	8:30	40	56	½
10.45	47	63	1	9:00	42	56	1
11:15	50	64	..	9:30	43	57	..
11:45	54	65	2	10:00	44	57	2
12:15 P. M.	55	68	..	10:30	44	58*	..
12:45	55	71	3	11:00	44	64	3
1:15	55	76	..	11:30	44	72	..
1:45	53	81*	4	12:00 M.	44	78	4
2:15	48	84	..	12:30 P. M.	44	82	..
2:45	48	85	5	1:00	44	86	5
3:15	44	87	..	1:30	44	88	..
3:45	42	87	6	2:00	42	90	6
4:15	42	87	..	2:30	42	90.5	..
				3:00	40	89	7
				3:30	38	88	..
				4:00	39	88	8
				4:30	36	86	..
				5:00 P. M.	34	85	9
				6:00 A. M.		58	22

*Wetting started.

Set. No. 1 seems to show a strong rise in internal temperature between the second and fourth hours, possibly due to slowness in wetting and warm weather. In Set No. 2 this rise of temperature seems to be retarded by early wetting and cold air temperature, but in spite of this retardation the pavement developed an internal heat slightly higher than the first pavement tested.

"Considering the use of Lumnite cement in freezing weather, it would seem that the internal heat developed (58 degrees at 22 hours) would protect the pavement until set had occurred. Whether the surface of the slab would freeze and scale has not been determined, but it is planned to observe the temperature at the surface of the slab on another short experimental stretch to be laid during the winter when the weather is colder. No difficulties occurred in the handling, mixing or placing of this cement and a great early strength was obtained. What might be considered as minor disadvantages accompanying the use of the quick-hardening cement are noted as follows: (1) The mix must be wetter than normal (ordinarily this would not be difficult.) (2) The excess material slopping on the forms and on older pavement must be promptly removed or great difficulty will be had in cleaning pavement and removing forms. (3) Wetting must be started immediately after the brooming, between one hour and a half and two hours after placing, and kept up continuously for 8 hours. On extensive work this would be an expensive item in men and materials as one man per 250 feet was found necessary to properly do the job."

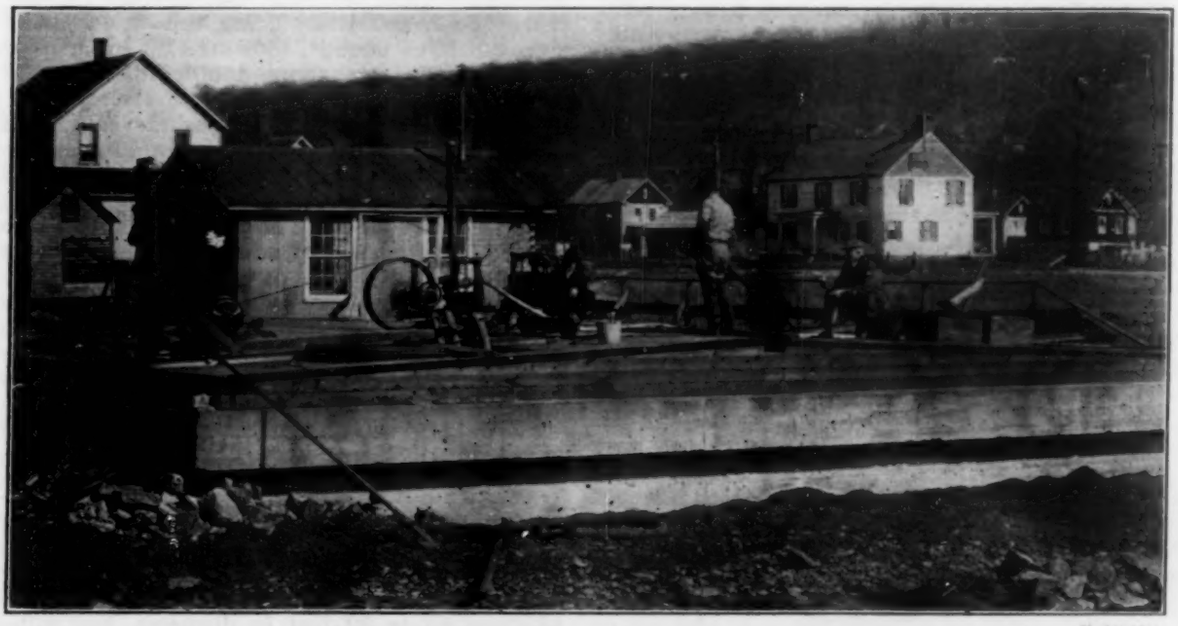
Cleaning Haskell Septic Tanks

Hand removal and haulage of 175 wagon loads of sludge abandoned for pumping by electrically operated diaphragm pump and forcing through seven hundred feet of hose.

The town of Haskell, N. J., at which one of the Du Pont Company's powder plants is located, delivers its sewage to a double septic tank, a dividing wall making two tanks, each 38 feet by 23 feet. A short time ago it was found that these tanks required cleaning, as the accumulation of sludge had become fairly thick. In addition to the regular sewage matter there were a considerable number of small sticks from about the size of clothespins to double that size which had dropped into the tank when a roof was put on about a year previous. Some of the sticks had sunk to the bottom of the tank, while others were suspended in the liquid sludge at different levels.

The combined sludge and liquid in each tank was about six feet deep, and preliminary to cleaning, an open discharge diaphragm pump was used to remove the water from one compartment. Progress was slow on account of the frequent clogging of the valves by small sticks and after about three feet of water had been removed it was found that the open pump could not handle the remaining material.

Believing that a considerable quantity of sludge would have to be removed, a windlass and bucket had been provided for raising the sludge to the



CLEANING SEPTIC TANK AT HASKELL, N. J.

surface, one man on the inside of the tank shoveling the sludge into the bucket and six men on the ground raising it and dumping it into a tank wagon which, with two horses and a driver, was to haul it to a field across a small river, on one bank of which the septic tank was located. The nearest point for depositing the sludge was about 200 feet from the tank in a straight line and the farthest point about 700 feet, the distance to each of these points being somewhat greater by wagon road.

Based on an average depth of 3 feet in each tank, it was calculated that approximately 5,200 feet of sludge would need to be removed and transported to the field. Owing to the rough character of the ground and the limited strength of the bridge across the river, loads of more than one ton did not seem practicable and this would therefore mean about 175 loads of sludge. It was apparent that this method would be slow and extremely expensive and other possibilities were looked for.

Electricity was available within 20 feet of the tanks and a 5 h. p. electric motor could be obtained readily, while the DuPont Company had plenty of 2-inch fire hose. It was therefore decided to try an electric-driven pump for raising the sludge from the tank and discharging it into the wagon, which would save considerable time and require less than five men, one man remaining in the tank to handle the suction hose and one at the top of the tank to handle the discharge hose. A 3-inch single Marlo Mud Hog diaphragm force pump was obtained and fastened on a set of wooden skids so that it could be moved from one tank to the other. With it were used a 25-foot length of 3-inch suction hose with couplings, 700 feet of 2-inch rubber-lined fire hose in 50-foot lengths; an air chamber on the pump discharge made of 3-inch diameter pipe 42 inches high. The pump was driven by a 5 h. p. 1,200 r. p. m. 3-phase Allis-Chalmers squirrel-cage motor. The pump worked so well that it was suggested discharging the sludge directly onto the field, and 350 feet of 2-inch discharge hose was connected to the pump and carried across the river to the field. This operated so smoothly that more hose was added, reaching a maximum of 700 feet, and carried the sludge to the far end of the field.

As the work progressed a technique was developed to meet the minor difficulties that arose. The sticks in the sludge sometimes clogged the ball valves of the pump, and they were removed by opening the valve chamber. Because of the 20-foot suction lift, the pump was primed, but the air in the suction hose, after passing through the pump, could not get out of the discharge hose and the valves became air-bound. To remedy this, a ⅛-inch pet cock was placed about 6 inches from the bottom of the air chamber to bleed out this surplus air. Probably a ¼-inch or even a ½-inch valve would have been better, as the small orifice in the ⅛-inch pet cock clogged up frequently.

As a further prevention of trouble from sticks, two screens were made, box shaped and each about 12x12x24 inches. The 12x12 ends were solid, and the remaining sides were covered with 1-inch mesh chicken wire. In one of the solid ends a 3-inch hole was cut and a screw flange bolted, to which the suction hose coupling was screwed. Later, when pumping was begun on the second tank, it was found advisable to change the chicken wire to 2-inch mesh. The 1-inch mesh became clogged with cloth, hair, strings, sticks, etc., and when thoroughly clogged it took a man about one hour to clean it. Using a 2-inch mesh it was found unnecessary to clean the strainer at all since, although it kept the large sticks out, the other materials worked through the screen and through the pump. Generally the holes in the 2-inch mesh were partly clogged so that the effective diameter of the opening probably did not exceed 1 inch. When about half the material had been pumped out, the one-inch mesh screen was again used, as most of the clogging material was found in the top half of the tank.

The discharge end of the hose was supported above the ground surface so that the operator at the tank could see the stream flowing from it, and if this decreased he would instruct the man inside the tank to raise the suction slightly, so that the pump could take less solids and more water. At first, before this method was developed, a considerable amount of sand was encountered and the pump was allowed to take all it could, as a result of which the discharge hose clogged up solidly with sand and the diaphragm in the pump burst. When the pet cock was connected in the air chamber a pressure gauge was attached at the same point and this gauge showed a pressure of twenty pounds when pumping sludge through 350 feet of hose. Each night when work was shut down, the suction hose was thrown into the river and the pump run for a few minutes in order to thoroughly clean all solid matter from the discharge hose, and when doing this the pressure dropped to ten pounds, showing that the friction of the sludge was about double that of clear water.

Cleaning the first tank required eleven days of 10½ hours each, two men using the open discharge diaphragm pump part of the time, and the closed discharge force pump the remaining part. The second tank was cleaned in six days of 10½ hours each, with two men using the force pump alone, the better time being due to the screens and other details that had been worked out and to the greater familiarity of the men with the operation. The work was superintended by H. H. Van Kleek, who is in charge of sanitary work for the DuPont Company at Haskell.

Washouts on California Roads

Additional information has been received concerning damage done to California roads by the excessive rains of this Spring. Up to the middle of March the slides in Division 1 had reached 150 in number. Twenty-seven large trees, some of them up to 10 feet in diameter, had fallen across the highway and much labor and powder

were required to open up a sufficient width of highway to permit traffic to pass through. At that time P. A. Bedford, division engineer, estimated that the slides had reached a total of 150,000 cubic yards, with more coming after each rain. At that time the rainfall had reached 70 inches in some parts of the district. In some places the entire roadbed had been carried away and in others huge boulders as well as large trees had crashed down the mountain sides and completely filled the highways.

These slides are being handled economically in some places by sluicing the earth across the highway and down the lower slope. In one place a giant monitor, such as was used in the early hydraulic mining, was used effectively in removing a slide from the highway at low cost.

Constructing Reinforced Concrete Reservoir

Special devices for supporting reinforcing steel while pouring concrete; for handling, bracing and pulling forms; and for mixing and placing concrete.

In 1924 the Cincinnati waterworks began constructing a reservoir known as the Eastern Hills Reservoir to serve what is known as the Eastern Hills suburb, and the contractor for the reservoir employed some interesting methods and appliances in connection with the construction, and completed it in 200 days less than the time allowed by the contract. The contractor was The Max Penker & Sons Company of Cincinnati. He was awarded the contract on May 7th, 1924, and began work the next day, the contract being per unit price with penalty and bonus considerations.

The reservoir is 400 feet square by 30 feet deep with a capacity of 35,000,000 gallons and cost approximately $600,000. The construction involves 70,000 cubic yards of earth excavation, 24,000 cubic yards of concrete, 1,000 tons of reinforcing steel and 13,000 square yards of gunite. The design was prepared by J. A. Hiller, superintendent of waterworks of Cincinnati. The reservoir is enclosed with a cantilever reinforced concrete wall and a concrete bottom, with provision made for later building a concrete roof; this provision consisting of constructing concrete column footings spaced 25 feet apart in both directions throughout the reservoir. The inner face is battered and the outside face is vertical with spandrel arch indentations between battered buttresses. A walk is supported on concrete brackets near the top of the wall. A concrete key under the footing of the wall 7 feet wide at the top, 5 feet at the bottom and 4 feet deep prevents the wall from sliding on the bottom slab, this key being tied to the main wall with shear and tension steel.

The excavation was done with a ¾-yard Northwest gas shovel, a 60-horsepower tracklayer Best tractor, four 5-yard LaPlant-Choate dump wagons, four Roy track multi-unit ¾-yard wheel scrapers and a 12-foot Acme traction grader. The average depth of cut was about 9 feet and the average excavation in a 10-hour day was a little less than 500 cubic yards. Two 10-hour shifts a day were worked, the contractor using four 1,000-watt flood lights for illumination at night.

In building the walls, the supporting of the reinforcement more than 30 feet high required special consideration. A strip of concrete 4 inches thick was poured into the bottom of keyway to support the vertical reinforcing steel. Then large 1¼-inch bent bars were placed vertically, with alternate bars extending above the footing subgrade 22 feet and 14 feet, respectively. These were held in position by frames until the concrete key had been poured and set, when the steel could support itself and the frames were removed. The frames were spaced 10 feet apart, each frame consisting of a 2x12 base member spanning the opening of the keyway and blocked up to the correct elevation, and two uprights forming an A frame. Two 4x4s with cleats nailed at 6-inch intervals (this being the space between vertical bars) were attached horizontally to the upright pieces of the frames and supported the bars in correct position while the concrete was being poured. A horizontal 1-inch bar was wired to the tops of the upright bars.

The horizontal steel in the top of the footing was suspended from 4x12 timbers supported at each end by the side forms of the footing and in the center on a steel angle clamped to the vertical reinforcing bars.

The horizontal steel near the inside and outside faces of the wall was supported and spaced by frames each consisting of two 4x4s, one vertical and the other sloping, giving the distance between horizontal bars approximately 1 foot at the top and 6 feet at the bottom. Blocks were nailed to the outside of the 4x4s to give the required spacing, on which the horizontal steel rested. The wall was built in 25-foot sections, and one of these frames was used at each end. These frames were removed after the wall forms had been placed. As the wall was built in alternate sections and the horizontal bars extended past the construction joint, the steel for the second or filler sections was wired to the protruding ends of the steel already in place without the necessity of using frames.

The forms were made up in panel sections 25 feet long so that they could be used over again and were constructed of wood, the cost of steel being considered prohibitive. They were built of 2-inch tongued and grooved lumber with 4x4 studs 18 inches on centers and 6x8 wales 3 feet on centers. The forms for the buttresses and the soffits for the arches were chamfered 1 inch to the foot to permit them to be removed easily. The forms rested on bevelled wood sills set

accurately to place on top of the footing, thus insuring the proper line and grade of the bottom of the panel. The tops of the forms were drawn to line and held in place during pouring by means of cables and turnbuckles. The wall forms were spaced and tied together with ¾-inch Universal cone nuts and rods spaced 3 feet vertically and with a horizontal spacing adjusted to the pressure of the concrete. These were left in the wall. Three complete forms were built, and each was used about twenty-one times.

Each panel form weighed about 9 tons and was handled by a gantry which spanned the wall and carried at the top four I-beam tracks placed transversely to the wall, on which ran trolleys which carried chains with Joyce double-acting screw jacks at mid-length and with hooks at their lower ends for fastening to the top of the panel form. This gantry was mounted on double flanged wheels that ran on two rails, one on each side of the wall. It was moved forward by prying under the wheel with crowbars or by use of block and fall. When a corner was reached, a stiffleg derrick was used to swing the gantry and the forms around the corner. When the chains had been attached to the form, the form was jacked loose from the concrete and by means of the trolley was swung free from the wall. The gantry then was moved along the track to the position for the next section and by means of the trolleys swung the form into its new position.

Pulling the outside form was difficult because of the adhesion of the buttress and spandrel arch form to the concrete, and the following device was used: Near each of the four corners of a panel two 4-inch I-beams about 3½ feet long were placed side by side vertically and bolted at the ends to two of the wales, the bolts running entirely through the form with the heads counter sunk on the inside face. Between the two wales, opposite the center of each pair of I-beams, an 8x8 opening was cut in the form and filled with a ¾-inch steel plate flush with the on the wall through the medium of the steel plate, the form was forced away from the wall, all four jacks being used simultaneously. The work of moving wall forms was done mostly at night.

A central mixing plant was located just outside the north wall of the reservoir. It contained an elevated sand and gravel hopper which was filled by means of a power conveyor; cement sheds on each side which were reached by a ramp leading from the road to the north side of the plant and ending about 3 feet below the level of the cement shed floor; and a 28S Blaw-Knox electric mixer which was placed directly under the aggregate hoppers. The charging hopper of the mixer was at the level of the cement shed floor. Blaw-Knox adjustable measuring batch hoppers for the sand and gravel were suspended from the main hoppers directly over the mixer hopper. The aggregate hoppers had capacities for 100 yards of sand and 200 yards of crushed stone. Additional storage was had at the railroad siding. The cement sheds had a capacity for nine cars of cement with reserve storage elsewhere. The maximum output of the entire mixing and placing equipment taken as a unit was 35 cubic yards an hour. An average of 250 cubic yards of concrete a day was poured for four consecutive weeks and as much as 350 cubic yards a day was not uncommon.

The concrete was mixed 1:2:4 using Atlas portland cement, washed and graded sand and crushed gravel, a large percentage of crusher dust being used to increase the impermeability. For the same purpose hydrated lime to the extent of 10% of the volume of the cement was added. The concrete was mixed in the central mixing plant and distributed to the various points in the reservoir wall by means of a narrow-gauge track laid just inside the wall footings and making a complete circuit of the reservoir. This track curved in under the central mixing plant so that the cars could be run directly under the discharge spout of the mixer. The concrete was received in bottom dump buckets of one-batch capacity which were carried on 4-wheel flat cars, hauled by tractors mounted on car wheels, these being Fordson tractors on Adamson locomotive attachments. A mixer man and four or five laborers were inside face. When the concrete had set and it was desired to remove the form, a jack was placed with one end on this steel plate and the other against the vertical I-beams refered to, and by operating the jack and exerting pressure used at the charging end of the plant and another to keep the track clear of spilled concrete.

When the concrete had been carried to the desired point the buckets were swung from the cars by means of a 10-ton traveling wooden stiffleg derrick equipped with a 2-drum Mead-Morrison hoist engine for boom and hoist and a 1-drum engine of the same make for the swing, the engines being operated by G. E. induction motors. The derrick was mounted on double flanged wheel cradles, there being a 3-wheel cradle under the mast and a 2-wheel cradle under each layleg end. A trussed 10x12 beam tied the ends of the two laylegs together and supported the engines. About 20 tons of pig iron was placed on a platform at each layleg end as a counterbalance. The derrick was moved from place to place with its own power by means of a niggerhead on the hoist engine, a 1-inch rope and a deadman.

Two wooden gantries were used for placing the concrete, one located on each side of the form gantry. They were constructed similar to the form gantry except that a sloping platform hopper was suspended from the top beam of each. This hopper had a slope of about 3 inches to the foot with the lower edge centered over the top of the wall forms; three telescopic chutes being connected to the lower edge of each platform so that the concrete could be deposited at will at different points of the wall

section. These gantries were moved on the same tracks that carried the form gantries.

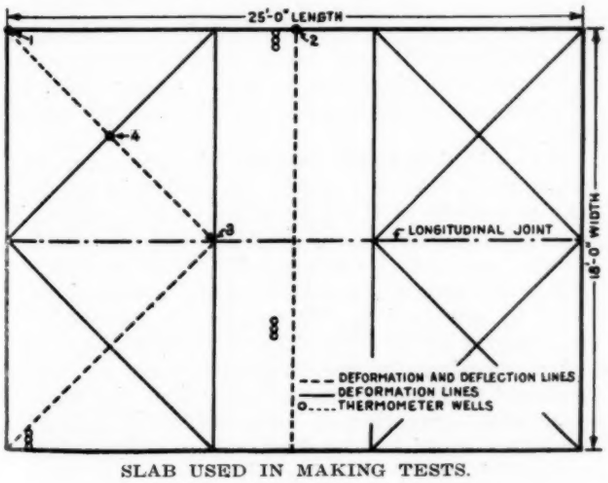
The contractor's plant was designed by Theodore Penker, president, Irwin Penker, vice-president, and W. V. Schmiedke, chief engineer, of the contracting company. Ben Harig was superintendent in charge of operations and Donald Allan was job engineer.

Effect of Moisture on Concrete

Maximum warping and surface deformation of road slabs resulting from non-uniform distribution of moisture.

Investigations were conducted by the Engineering Experiment Station of Purdue University in cooperation with the U. S. Bureau of Public Roads, under the supervision of Prof. W. K. Hatt and Prof. R. B. Crepps, the primary purpose of which was to measure the maximum warping and surface deformation of a concrete road slab resulting from non-uniform distribution of moisture, as a basis for estimating possible initial stresses. The tests also yielded data of expansion and contraction of concrete, useful in the design of concrete structures. The methods employed and conclusions drawn were described a few weeks ago by Prof. Hatt in a paper before the American Society of Civil Enginers.

The investigations were divided into two sections, namely: (1) Observations on a concrete road slab, 7 inches thick, 18 feet wide, and 25 feet long, resting on a porous subgrade, and covered with a tent and housed in a shed to control the distribution of moisture and the effects of temperature; (2) tests of strength and length changes of small beams, some partly and some uniformly saturated.



SLAB USED IN MAKING TESTS.

The following phenomena were examined.

1. The maximum distortion (including deflection and fiber deformation) of the concrete slab, caused by nonuniform distribution of moisture.
2. The effect of moisture changes on the modulus of rupture and compressive strength of concrete determined by tests of the beams, the dimensions of which were 4 inches by 7 inches by 4 feet, and cylinders 6 inches in diameter by 12 inches in length.
3. The volume changes in the concrete beam specimens due to exposure, including warping due to partial saturation.

Approximately 40,000 observations were involved in the study of deformation, 3,000 in those of deflection, 600 of strength, 1,000 of weight, and 1,500 of temperature. The conclusions drawn from these tests are given by Prof. Hatt as follows:

CONCLUSIONS DRAWN FROM THE TESTS

From the results of the various studies the writer has reached the following conclusions:

1. The strength of concrete, like that of wood, varies with its moisture content. While the law relating to moisture content and to strength was not determined throughout various ranges of moisture content, it appears that saturated concrete will have from 80 to 85 per cent of the strength of dry concrete.
2. The thermal coefficient of expansion of concrete varies with the temperature and moisture condition of the concrete.
3. Concrete expands when immersed in water and contracts on drying. The degree of change of length varies markedly with the characteristics of the brand of cement, with the richness of the mix, with the size of specimen, and with the conditions of exposure. Measurements begun after the initial hardening of the cement show that concrete may expand 0.01 per cent due to the absorption of moisture, and may contract 0.06 per cent when exposed to dry air. These changes continue. To these values should be added the changes in length during the initial setting of the cement.
4. Concrete road slabs warp upward at the corners and at the edges when the surface becomes dry, and also when the bottom absorbs moisture from the subgrade. Drying the top surface of the slab under observation deflected the corners upward 0.12 inch. When the bottom of the slab was saturated from a water-filled subgrade the upward corner deflection reached 0.20 inch.
5. This curling upward of the corners of the road slab presents a cantilever beam to the load of a passing truck. The results of the tests indicate the presence of an initial stress in the surface of the road slab arising from the warping.
6. A combination of shrinkage from drying and from a fall ir temperature will produce maximum shrinkage strains. A combination of a drop in temperature and a rainfall may retain the concrete at its previous length. The friction of a road slab on its subgrade is an element favoring the production of cracks.

7. To be durable, concrete structures should be designed for the least favorable conditions. Stresses arising from the effect of temperature and moisture as well as those due to dead and live loads should be considered.

8. Without careful curing, concrete masses will undergo excessive surface shrinkage against their rigid cores, thereby favoring surface cracks. Therefore steel reinforcing should be placed near enough to the surface to withstand these shrinkage strains, and at the same time far enough below the surface to be protected against corrosion.

9. Foreign experiments show the benefit of early and careful curing of concrete in reducing final shrinkage. The greater part of the shrinkage of mortar specimens has been found to take place in the first 10 hours. These foreign experiments also show the greatly increased shrinkage of mortar mixed with an excess of water.

10. Since the results of measurements of expansion vary with several factors, such as the size of specimen, the time of initial measurement, and the exposure, the method of such tests should be standardized.

The writer believes that the following are the requirements for concrete structures exposed to the weather:

(a) A Portland cement of normal volume constancy and a clean, well graded aggregate.

(b) An impervious concrete of proportions not less than 1:2:4.

(c) A time of mixing of not less than 1 minute and preferably 1½ minutes for the production of uniform concrete.

(d) A concrete mixed with a minimum amount of water appropriate to the work at hand.

(e) Careful slicing of this plastic concrete against the face of the forms so that the reinforcing steel may not be exposed nor the surface require patching.

(f) Early curing begun just after the initial set and continued for a time depending on local conditions.

(g) Design of reinforcing steel and contraction or expansion joints to prevent cracking and the entrance of water.

Protection of Public Water Supply by Forest Cover

Varies with kind of soil. Reduces turbidity of water and silting up of reservoirs.

A paper with the above title was presented before the North Carolina section of the American Waterworks Association by W. W. Ashe, of the United States Forest Reserve. Mr. Ashe called attention especially to the fact that the protection afforded by the forest cover is not equal on all sites. The principal protective function of the forest cover is decreasing erosion of the soil on the watershed.

He said:—"On very sandy sites, whether the terrain is level or hilly, the protective functions of forest cover are of low value. Storm water is readily absorbed by such soils for the granulation of the sand is a constant feature. The forest cover, however, exerts a high protective influence upon clay and clayey soils, especially upon such as contain a considerable colloidal content and upon such as are subject upon denudation to excessive erosion during storms. The forest humus and the admixture of humus in the soil tends to maintain granulation of clayey soils and in this way to promote absorption of heavy rainfall. The many small channels in the soil, caused by the decay of roots, likewise promote absorption, especially in the lower soil and subsoil. The carpet of litter and leaves beneath the forest receives the impact of raindrops and such water as is not absorbed by the surface soil largely runs off over this litter in place of over naked soil. The more broken the surface, the steeper the gradient, and the longer the slope the greater is the protective value of the forest cover. Likewise the depth of the accumulation of leaves and litter is important, and forests which are burned and the litter beneath which has been destroyed, or reduced in thickness by fire or by excessive grazing, are less effective in affording protection to the soil than such as are in normal condition."

How much influence the forest cover may have in equalizing stream flow is an open question in most regions, but as a rule more storm water is absorbed by clayey lands which have a forest cover than when such lands are cleared or growing grass. Consequently on clayey sites there is a tendency for springs to fail when forest conditions no longer exist. On the whole, this greater regularity of underground flow more than compensates for the moisture removed from the soil by the trees in the forest.

The lessening of the silt carried by the runoff is beneficial not only because of the improved sanitary and physical property of the water but because it lessens the silting up of the reservoir and the resulting loss of storage capacity. Where the silt in the reservoir can be removed cheaply this may not be so important, but if such removal is expensive or difficult and silting up is rapid, this may be a matter of vital importance. In such cases it may be of immediate financial advantage to plant trees on the water shed, to diminish this silting and loss of reservoir capacity.

An additional advantage of trees on the watershed, and especially immediately around the reservoir, is the protection of the reservoir against wind influence. Agitation of the surface of the reservoir by wind is likely to prevent or delay sedimentation of the finer material carried in suspension. This may be lessened by planting wind breaks of trees around the edges of reservoirs. In the case of a long reservoir exposed to long sweeps of the wind, the author suggests separation of such reservoir into two or more sections by transverse embankments on which trees are planted.

PUBLIC WORKS

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates

United States and Possessions, Mexico and Cuba $3.00 year
All other countries ..... $4.00 year
Single copies, 35 cents each

Change of Address

Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Pennsylvania 4290
Western Office: Monadnock Block, Chicago

A. PRESCOTT FOLWELL, Editor

CONTENTS

ORLANDO WATER AND LIGHT PLANT. Illustrated. By W. W. Mathews..... 197
LIME IN SEWAGE TREATMENT. Illustrated By T. C. Schaetzle..... 201
Gravel Roads in Iowa..... 203
Waterworks Maintenance in Springfield..... 204
REBUILDING CALIFORNIA HIGHWAYS. Illustrated. By J. C. McLeod..... 204
Winter Use of Highway Maintenance Force..... 207
Cost of Maintaining Rhode Island Roads..... 207
Indiana Sewer Construction..... 207
Dating Concrete Pavements..... 207
Suspension Bridge to Facilitate Construction. Illustrated 207
MAKING ROCHESTER'S ASSESSMENT MAPS 208
Pavement Cuts in New Brighton..... 209
QUICK-HARDENING PAVEMENT IN RHODE ISLAND 209
CLEARING HASKELL SEPTIC TANKS. Illustrated 211
Washouts on California Roads..... 212
CONSTRUCTING REINFORCED CONCRETE RESERVOIR 213
EFFECT OF MOISTURE ON CONCRETE. Illustrated 215
Protection of Public Water Supplies by Forest Cover 216
EDITORIAL NOTES 217
Trucks and Road Destruction—Surface Water vs. Ground Water—Discarded Bed Springs, et al.
BIOCHEMICAL OXYGEN-DEMAND TEST.... 218
FORMS FOR CONCRETE PAVEMENT..... 219
REFUSE DISPOSAL AT HIGHLAND PARK... 220
Municipal Water Consumption..... 221
HIGHWAY MAINTENANCE IN SOUTH CAROLINA 221
WATER MAINS LAID DURING 1924...Table... 222
DETECTION OF LEAKAGE AND WASTE. Table 223
Flood Protection on Highway Embankment..... 225
Chat Roads in Missouri..... 225
VERTICAL PRESSURE OF EARTH FILLS. Illustrated. By C. N. Conner..... 226
Some Traffic Statistics..... 227
RECENT LEGAL DECISIONS 228

Trucks and Road Destruction

It is somewhat difficult to understand why Secretary Jardine, in his address before the Mid-West Transportation Conference, abstracted in this issue, should have placed such emphasis on the statement that motor trucks do not destroy present-day roads, although he admits they do wear them out in time. Tests made during the past few years have shown that if only pleasure vehicles used the roads, even by the millions, they would last many—perhaps a hundred—times as long as when a few heavy trucks are added to the traffic; and where spring thaws weaken the sub-grade, pavements of the highest class are practically destroyed by heavy trucks, some states retaining the right to forbid the passage of trucks over its roads during such periods. The idea of constructing special roads for truck traffic and excluding trucks from others to prevent their destruction or rapid deterioration is becoming increasingly rather than decreasingly important.

Where trucks are not destroying our roads, it is because they are prevented from doing so by legal limitations on wheel loads and by constructing the roads to carry loads up to those limits. But if trucks could be excluded from certain roads, $20,000 a mile would in most cases provide as satisfactory and durable a pavement for the light vehicles using them as $50,000 does for pavements carrying truck traffic.

Surface Water vs. Ground Water

It is quite a popular idea that ground water is pure water and surface water is not. While this may be accepted as a general statement, it has many exceptions, especially the former part of it. In fact, very few ground waters are free from relatively high mineral contents, and more than is generally suspected carry dangerous pollution.

A case in point is furnished by the first article in this issue. The engineers found that at Orlando the ground water was not only undesirably hard, but that it was open to suspicion on the score of pollution because of the fact that the sewage of the city was discharged into the sand and presumably would reach the wells still containing an uncertain amount of its dissolved and even suspended pollution. The surface water found in the numerous lakes in the vicinity is softer, the amount of purification required is at least no greater, and its use eliminates the necessity of deep well pumping. The engineers were undoubtedly justified in their selection of the surface supply in this instance.

Discarded Bed Springs, et al.

The writer has been told, by superintendents of refuse sorting plants, that one of their most troublesome problems is the disposition of bed springs and certain other light but bulky metallic objects. The superintendent of public service of Highland Park, Mich., has apparently solved the problem. He cuts them into short lengths by use of large, heavy shears driven by motor power and sells them for $7 or $8 a ton. Tin cans and other small metals are pressed into blocks and sold for $4.50 a ton. Even if these sums do not pay the cost of preparation, any other disposal would probably cost more.

Biochemical Oxygen-Demand Test*

Practical application of this test to the routine work of operating a sewage treatment plant. Easily understood by average engineer or operator.

By J. A. Childs.†

The purpose of this paper is to discuss briefly the practical importance of the biochemical oxygen-demand test as applied to the routine work of the sanitary engineer or the operator of a sewage treatment plant. The details of the actual procedure used in determining the biochemical oxygen-demand of a sample by what is known as the excess-oxygen method, together with authentic and very complete information relative to the apparatus and chemicals required and the precautions to be observed, are contained in various publications.§

VALUE OF THE TEST

The value of this test, when compared with other analytical determinations ordinarily applied to sewage, is very clearly stated in the following paragraphs taken from Public Health Bulletin No. 132 on "Sewage Treatment in the United States":

"The test appears to furnish by far the most valuable information as to the behavior of the plants and the efficiency of the various devices used in sewage purification. With suitable precautions, a high degree of accuracy is attainable, and once a routine has been established the time and labor involved is no greater than is required for a nitrate determination or an oxygen-consumed test. The oxygen demand determination has the decided advantage that it is applicable to sewage in all stages of purification, and the information that it furnishes can be used independently of the results of other determinations.

"When dilutions are made with raw sewage, the degree of dilution can be used in estimating its effect on a receivng body of water. In the absence of bacteriological data the determination of the oxygen demand of a stream above and below the point where an effluent is discharged is probably the best index of the effect of the sewage on the stream.

PRINCIPLE EASY TO UNDERSTAND

The greatest drawback to many of the analytical tests that have heretofore been commonly applied to sewage is that the results are expressed in chemical terms which are not readily understood by the average sewage-plant operator, or for that matter by many engineers. The oxygen-demand test is simply a measure of the oxygen that may be required in a given time (usually five days) by a sewage, trade waste, or water, in order to replace the oxygen that combines in a natural manner with the organic or mineral matter in the water, sewage, or waste under consideration. It may be likened somewhat to a measurement of the amount of air required to burn a given quantity of wood or coal in a furnace, the amount of air required depending upon the character or relative heating value of the fuel. Likewise, a strong sewage or waste will require more oxygen to render it stable than will a weak sewage or waste. Thus it is easy for almost anyone to understand that a sewage having a 5-day oxygen demand of 200 is about twice as strong as the one having a 5-day oxygen demand of 100. It is a test that places the highly-trained chemist upon a common ground of understanding with the average plant operator or engineer.

AN INDUSTRIAL ANALOGY

A sewage-treatment plant has been likened to a factory: the raw sewage representing the raw material coming in, and the treated effluent representing the finished factory output. In order that an industrial establishment may operate successfully, the finished product must come up to certain standards. Each department must operate with a certain degree of efficiency, or the industry cannot survive. It is the practice in most industrial establishments to keep a close check on the operating efficiency of each department, in order that the costs of producing the finished product may be accurately known. The operation of a sewage-treatment plant may be patterned after an industry operated on a cost basis—the screens, settling basins, filters, re-settling tanks, etc., representing the various departments of the industrial establishment. The cost of the construction and operation of each unit of the plant can be accurately determined.

By the application of the oxygen-demand test the relative value of the treatment can be measured at every step of the process, and the efficiency of every step thus determined. This information is of considerable value in the case of existing sewage-treatment plants, because nearly all plants must eventually be enlarged. With information at hand as to the relative efficiency of every step of the process, it is possible to so coordinate additions to the plant with existing works as to produce the desired results at a minimum cost, thus effecting savings to the taxpayers amounting to thousands of dollars.

As an illustration of this point, we might take for consideration a sewage in which the settleable solid content was relatively small and of a nature that would not settle out readily. The dissolved organic content of such a sewage might be relatively high, due to the presence

*Paper before Conference on Sewage Treatment at Iowa State College.

†Engineer, Division of Sanitation, Minnesota State Board of Health.

§"Studies on the Treatment and Disposal of Industrial Wastes," Public Health Bulletin No. 97, U. S. Public Health Service, October, 1918. "Sewage Treatment in the United States," Public Health Bulletin No. 132, U. S. Public Health Service, July, 1923. "Standard Methods of Water Analysis," American Public Health Association. 1923 Edition.

of certain industrial wastes. When the oxygen-demand test is applied, it would probably be found that the reduction in oxygen demand by sedimentation would be relatively low, this indicating that the oxidizing process, to be carried out in the percolating filter, sand filter or activated sludge treatment, would constitute the greater part of the treatment if a well-stabilized effluent was to be turned out. In such a case it might be possible to enlarge upon the secondary treatment without the expense of materially increasing the settling-chamber capacity of the plant.

APPLICATION TO STUDY OF INDUSTRIAL WASTES

Another instance of the value of the oxygen-demand determination would be the case where a plant had been designed for the treatment of ordinary domestic sewage of a normal strength, but where, due to the location of industries of various kinds in the municipality (such as cheese factories, creameries, paper mills, and packing plants), the strength of the sewage had so increased that the plant could no longer be operated satisfactorily. By the application of this test the municipality might be in a position to demonstrate that the just and reasonable procedure would be for each such industry to install a treatment plant, by means of which its waste could be so reduced as no longer to interfere with or to throw an excessive burden upon the operation of the municipal sewage-treatment plant. The effect of the addition of industrial waste to a domestic sewage can be quite readily understood when it is realized that creamery waste may have a 5-day oxygen demand of from 500 to 5,000 p.p.m., cheese-factory waste as high as 30,000 p.p.m., packing-plant waste of from 500 to 2,500 p.p.m., and rendering-plant waste as high as 70,000 p.p.m.; while the 5-day oxygen demand of normal untreated domestic sewage will seldom average more than 200 p.p.m.

A MEASURE OF STREAM POLLUTION

This test is also of considerable value in determining the effect of the discharge of sewage or wastes into a stream or lake. In cases where the municipal sewage and the industrial waste may be discharged into a stream through separate outlets, this test often furnishes a very definite measurement of the relative effect of the different materials contributing to the pollution of the stream. In case sewage treatment may be necessary to relieve a nuisance, the oxygen-demand determinations (together with dissolved-oxygen tests) will constitute an intelligible basis from which to determine the degree of treatment that may be required. The oxygen-demand test, in connection with the bacteriological and dissolved-oxygen tests, may be used as a basis for specifying the degree of contamination to be permitted in any given stream or lake, thus enabling the engineer to proceed intelligently with the design of the necessary treatment works.

SIMPLICITY AND IMPORTANCE OF THE TEST

As has already been stated, the oxygen-demand test is one which may be very readily understood by the average engineer or the operator of a sewage-treatment plant, or in fact anyone who may not have had the opportunity of acquiring a technical education. Even if this test were not a very rational one from a technical standpoint, it would commend itself to general use for the reason that it can be so readily understood by the average layman. It is capable of assuming the same relative importance, in connection with sewage-treatment and stream-pollution problems, that the butter-fat determination is to the dairy farmer, or the B.T.U. test to the user of coal.

Forms for Concrete Pavement

Smooth pavements necessitate use of reliable steel side forms. State specifications. Recommended qualities.

The North Carolina Highway Bulletin publishes an article by C. N. Conner, state construction engineer, entitled, "Form Setting and Its Relation to Riding Qualities of Concrete Pavements." Mr. Conner introduces the article by stating that a concrete road that is straight, true and smooth can be attained in only one way—"the use of a reliable steel side form that will stay true and smooth throughout the construction of the road. The form must be light enough to be handled economically and strong enough to stand maximum abuse." He quotes A. T. Goldbeck of the Bureau of Public Roads as saying: "Unevenness of side forms is an inexcusable defect and results in an uneven surface."

"The day when road contractors could afford to worry along with wooden forms has passed. High labor and lumber costs, rapidly increasing demand for greater yardage per day, have been important factors in sending lumber forms to the scrap heap. Of equal importance has been the fact that good road building cannot be done with lumber forms, which slide and bend, wasting time and material and making true grading an impossibility.

"Following the lumber forms came a flood of incorrectly designed, poorly built metal rails—flimsy, too complicated for ordinary laborers to handle with any speed, and with most of the faults which put wooden forms on the retired list. Rails that would not stand up against the pressure of the heavy concrete fills; rails that buckled under the weight of the subgrader and finishing machine; rails with loose parts that are constantly being lost, and rails that caught and held concrete."

Among the first steel forms used were some designated as the "hanging system," but back

as early as 1914 it was discovered that it was necessary for the base of the rail to have a bearing on the subgrade substantially the full length of the rail.

STATE SPECIFICATIONS

At the present time there is a wide divergence in the specifications for forms adopted by the states, some being very lax while others are very rigid. Some specify the weight of forms, others weight per foot, others the width of base, number of stakes to the rail and complete details. Nevada, Minnesota and Washington specify wood forms with no reference to steel forms. Delaware, Maine, Maryland and Virginia definitely prohibit the use of wood forms, while fifteen other states specify steel forms, four allowing wood forms on curves, two of them specifying curves less than 150-foot radius. A weight of 6½ pounds per foot is specified by New York State, 7 by New Jersey, 7 to 10 by North Carolina, 8 by Delaware and Virginia, 8 to 9 by Pennsylvania, 9 by Indiana and 10 by Michigan. In North Carolina the 7 pounds per lineal foot is specified for 5-inch forms, 8 pounds for 6-inch forms, 9 pounds for 7-inch, 10 pounds for 8-inch and 11 pounds for 9-inch, exclusive of wedges and pins. On all projects exceeding 3 miles in length new forms must be furnished.

RECOMMENDATIONS

In Mr. Conner's opinion the best form is a structural section of medium steel which will resist impact better than the softer steel sections now in general use. "The width on the top of most forms now on the market is about 2 inches. This, I believe, is unnecessary and perhaps dangerous. To my mind the top width should only be sufficient to carry the finishing machinery or tools, but the depth of the top should be ample to develop the web strength. . . . Joints in the forms should be so designed as to connect the abutting ends of the rails neatly and securely, so that there will be no sagging. Stakes should be inserted as close as possible to the rail joint . . . Joints between sections on the two sides must not be opposite but should be staggered whenever possible. . . . There should be not less than three stake pockets to a 10 or 12-foot section, preferably an extra stake pocket for emergency purposes or four stake pockets per section; two pockets located as close as possible to the rail joint, as the joint is the weakest point in the line of forms."

If steel forms are bent so that there is a variation over 1/16-inch in 10 feet, they are not suitable for use. Forms should always be reset for lining concrete after the subgrader has completed its work. Forms should be placed on a solid foundation. When the subgrade soil will not support the form and the weight of finishing machine, tamper, strike board, etc., stakes are driven into the ground at frequent intervals to support the base of the form. This solid support is necessary, for when the moisture from the concrete penetrates the subgrade under the form, settlement follows unless provision is made to offset it. In one instance a test was made by driving stakes alongside the forms with their tops exactly level with them. The concrete was then placed and a finishing machine put in operation. While the machine was opposite the stakes a deflection in the form of 1.4-inch below the top of the stakes was noted. When the machine moved away the form recovered. This was the heaviest form made and also the heaviest finishing machine, but the subgrade was a soft alluvial deposit. On one job the subgrade was so soft that it was impossible to keep the forms to line and grade under a finishing machine, and the job was finally finished by hand.

Refuse Disposal at Highland Park

Highland Park, Mich., is a city of approximately 67,000 inhabitants adjoining Detroit. The collection of garbage and refuse is performed by the Department of Public Service, of which M. H. Zink is superintendent. The following facts concerning the recent operations of the department have been furnished to us by Mr. Zink.

During the ten months ending May 1, 1925, garbage was collected from a population of about 65,000, the total amount being 5,635 tons. July was the month of maximum collection with 740 tons and January the minimum with 418 tons. Collections are made twice a week from residences and daily from the business district. Four trucks were used about half the time and 3 trucks the remainder. The employees consisted of four drivers and six loaders. Collections are made from alleys, of which there are 33 2/3 miles, of which 23.87 miles is paved. The garbage is hauled to a pig farm, the average haul being 8½ miles round trip.

The total cost of the service for the ten months was $28,776, an average of $5.02 per ton. This includes the following items: One-half salary of superintendent, $1,042; labor, $16,430; contract with pig farm, at $1 per ton $5,635; disposing of dead dogs $267; gasoline and oil $1,650; miscellaneous supplies, $1,059; truck maintenance, $2,693.

Formerly the city burned the garbage in an incinerator located about a mile from the city. This is not used now, but a large brick furnace has been built connected to the incinerator chimney, in which are burned paper, dead leaves, old mattresses and other combustible rubbish. The grounds at the incinerator are used for treating metallic refuse also, preparing it for sale. Tin cans and other small metallic objects are compressed into blocks weighing about 35 pounds each, by means of a small, electric driven press furnished by the Economy Baler Co. This is operated by two men, who make about 270 blocks a day besides performing other duties about the yard. These metal blocks are sold for $4.50 per ton, f. o. b. the yard.

Larger metallic objects, such as bed and couch frames and springs, auto frames and fenders, etc. are cut up into short lengths by one man, using small motor-driven allegator shears, and in this form bring $7 to $8 per ton. Hot water tanks bring $5 per ton, heavy steel $10, and cast iron $12. The returns from scrap last year was $4,500. Broken concrete is run through a crusher and used by the city in concrete work, such as alley paving.

All operations at the yard are well organized, no large accumulation of materials is permitted, and it does not have the appearance of a junk yard or dump.

Street sweepings and rubbish with no sale value are taken to a dump about 5½ miles from the city.

Municipal Water Consumption

In the report of the Board of Water Commissioners of Springfield, Mass., for the year 1924, reference was made at several points to the consumption of water by the various municipal departments of the city. The Water Registrar reported that, of the water charges during the year 87.6% was for water used by private consumers and 12.3% for water furnished to various city departments at rates prescribed by the City Council but for which no payments are made.

This matter of charges and payments is explained elsewhere in the report as follows:

"The metered and unmetered consumption of filtered water by the various municipal departments of the city and the prescribed values of same are shown in the usual tabulation following. For proper and required accounting purposes, the total amounts of the prescribed values are entered at the close of the year in the Water Works books as *accrued earnings* from said service, and then have to be charged off as *uncollectable*, for the reason that payment therefor is prohibited by city ordinance. For a number of years meters have been installed on all new services connected for municipal purposes, and it is expected that meters will be placed soon on such of the older unmetered municipal services as may be practicably meterable. This should be done for the twofold purpose of locating and controlling unnecessary waste of water and the definite accounting for all consumption possible."

The tabulation referred to shows that of the water used by schools, 93% is metered, 91% of that used by public buildings other than schools, 76% of that used in public parks and 6% of that in public playgrounds, while that used for building purposes, by the sewer department, for street washing and sprinkling, and drinking purposes for animals is unmetered, and the fire hydrant service is charged for at $25 per hydrant. Over 40% of the municipal consumption is used by public schools, about 14% by other public buildings, about 16% by public playgrounds, about 10% for sewer flushing and the same for street washing and sprinkling.

Highway Maintenance in South Carolina

The organization for maintaining highways in South Carolina was described by A. T. Brown, division engineer of the State Highway Department, at the Sixth Annual Road Institute in Columbus, S. C., this spring. A brief abstract of Mr. Brown's paper is given below.

For highway work the State is divided into four divisions and each of these into districts. The districts approximate 4 counties each, but do not strictly follow the county boundary lines.

In the southeastern division the combination gang-patrol system is used. All roads are divided into patrol sections, the length of each depending on the importance of the road and the difficulty of maintaining it. The average length is about eighteen miles. In charge of each section there is a patrolman who is either a driver or machine operator. In addition to the patrol, there is a floating crew for each district subdivision—approximately a county. A superintendent is in charge of each subdivision and the work of both the patrol and the floating crew is under his supervision. The superintendent reports to the supervisor in charge of the district.

The patrols handle all light work such as dragging, patching, surfacing and filling small washes. The center or floating crew, who handle all heavy machinery, make extensive repairs. The patrol is not supposed to do any extensive work which would diminish his effectiveness, which lies in his ability to cover the entire section in the least possible time.

The average patrol consists of four men, including the driver or machine operator in charge. The equipment consists preferably of a light caterpillar tractor, a light truck with dump body, a seven or eight-foot grader, a three-way crown maintainer, and the necessary small tools such as shovels, picks, axes, etc.

The floating crew carries one or more heavy tractors, ten or twelve-foot graders, and an extra light truck for each patrol section. A central shop serves the floating crew and also makes repairs on the patrol equipment. This is placed in the town nearest the center of the territory covered by the floating crew. Where there is a town convenient, patrol headquarters is located there, but otherwise it is located at the home of the patrolman.

In dividing the road into patrol sections, it has been found more satisfactory to have all of one patrolman's section in a continuous route rather than have him cover two or more short sections radiating from a town. On the other hand, the roads covered by a floating crew radiate from the center shops, and as South Carolina roads are laid out to connect county seats, the shop is generally located at a county seat.

The patrol system, in addition to insuring quick attention to the roads, places upon one man the responsibility of keeping up both road and equipment. It also allows a rating of employees based directly upon the general condition of their respective roads and equipment. All grades of maintenance employees are divided into four classes: excellent, good, fair and poor. A man showing a poor rating for two consecutive months should be relieved and also one showing a fair record for three consecutive months. The rate of pay for each employee should depend upon the ratings for the three months previous. This difference is not great, but in the case of a road machine operator receiving $60 a month in the lowest grade, five dollars per month additional is added for each grade. The grading is based upon a merit and demerit system, the supervisor requiring the employee in writing to submit an explanation of each delinquency and if this explanation is not satisfactory demerits are charged against him. Neglect of equipment, reporting late to work, and discourtesy to the traveling public are some of the matters incurring demerits.

The human element is important. The superintendent must not merely be a foreman requiring work for a required number of hours, but should display initiative and executive ability. He should be able to select men who are trustworthy and ambitious. As the superintendent is the official who comes most closely in contact with the men and the public, the wise selection of these is, perhaps, one of the most important steps in building up the organization.

When an organization has been built up of good men capable of carrying on the work successfully, such men should be retained. A spirit of loyalty to the work should be fostered. Each employee must appreciate his responsibility and the limit of his authority, realizing that he is one unit in the organization.

Summing up, Mr. Brown said: "Proper organization, which is the most important part of maintenance, is effected by determining the proper system of maintenance; care in apportioning the work among the different units, giving suitable and ample equipment to each unit; location of unit headquarters at the most advantageous point; responsibility for the work of each unit placed directly on one man; careful consideration of the human element in selecting employees; fair and equitable system of rating the value of employees; realization of the importance of continuity of service of employees; and last of all, the item which is probably the most important of all, the building up of an organization spirit.

Water Mains Laid During 1924

Statistics received from waterworks officials since the publication of the tables in the April issue.

City and State	Municipal or private	Cast-Iron Mains Under 6"	6, 8, 10, 12"	Over 12"	Steel Mains 12" and smaller	Larger than 12"	Other kinds Kind	Size	Quantity
Alabama:									
Talladega	M	10,000	....	....	....	....	....	....	....
Arizona:									
Glendale	M	1,200-4"	....	....	....	....	Galv.	2"	400
Tucson	M	4,382	3,060	....	....	....	Temporary w. i.	1½" to 3"	4,600
California:									
Upland	M	....	....	....	....	....	Weight Iron	4"	3,500
Illinois:									
Evanston	M	....	16,312-6" 3,418-8"	....	....	....	....	....	....
Iowa:									
Mason City	M	1,300	2,700	....	....	....	....	....	....
Massachusetts:									
Clinton	M	50	....	....	913-2"	....	....	....	....
Orange	M	....	400-6" 432-8"	....	....	....	....	....	....
Lexington	M	96-4"	13,016-6" 208-8"	....	....	....	....	....	....
Minnesota									
Aurora	....	240-2"	....	....	....	....	....	....	....
Missouri:									
Cameron	M	4,030	....	....	....	....	....	....	....
Nebraska:									
Aurora	M	....	....	....	....	....	Byers w. i.	2"	280
Scottsbluff	M	1,400-4"	400-6" 500-8"	....	....	....	....	....	....
New York:									
Penn Yan	M	422-4"	....	....	....	....	....	....	....
Scotia	M	....	700-6"	....	....	....	....	....	....
Warsaw	M	800-4"	....	....	500-2"	....	....	....	....
Ohio:									
Ashtabula	P	None	7,270-6" 2,200-10"	None	4703-2"	....	....	....	....
Oklahoma:									
Hominy	M	1,600	....	....	....	....	....	....	....
Oregon:									
Portland	M	14.4 mi.	36.2 mi.	5.4 mi.	....	....	Galvanized	2"	13 mi.
Pennsylvania:									
Beaver Falls	P	1,475	4,111	None	None	None	Galvanized	1 in. & 2 in.	8,176
South Carolina:									
Union	M	100	1,840-6" 470-8"	....	....	....	....	....	....
Tennessee:									
Harriman	M	1 mi.	....	....	....	....	....	....	....
Texas									
El Paso	M	....	9,000	....	....	....	....	....	....
Virginia:									
Martinsville	....	5,500	7,200	....	....	....	....	....	....
Wisconsin:									
De Pere	M	....	2,000-6"	....	....	....	....	....	....
Ladysmith	M	1,000-4"	....	....	....	....	....	....	....
Mineral Point	M	None	1,650-6"	None	None	None	None		....

Detection of Leakage and Waste

Conclusion of table from page 149 of the April issue.

	How often are house-to-house examinations Made?	What other methods are used for detecting leaks in services?	Percentages of services metered	Detecting underground leaks in mains Methods employed	Frequency of surveys	Where are most underground leaks found?	How much leakage has been discovered and stopped?	Per capita Consumption per day
Alabama:								
Talladega	None	.....	100	None	.....	.....	Very little	110 gal.
Arizona:								
Glendale	Monthly	.....	65	Shows on surface	.....	.....	.....	90 gal.
Talladega	None	None	55	Most show on surface	.....	Fire hydrants	.....	205 gal.
California:								
Upland	None	.....	100	None	.....	.....	.....	175 gal.
Illinois:								
Evanston	None	.....	100[a]	Pitometer survey in 1922	.....	.....	.....	106 gal.
Rochelle	Quarterly	Microphone	100	Microphone and surface inspection	.....	Joints, valves and services	.....	150 gal.
Iowa:								
Mason City	Quarterly	Microphones and detectors	100	Watch sewer discharge: use electric leak locator when evidence of leakage	Almost continuous	Service connections	Pumpage decreased 60% in a few years	70 gal.
Massachusetts:								
Clinton	None	Aquaphones	99.5	None	.....	Lead connections	.....	27 gal.
Orange	Monthly[b]	Microphone	100	Listening on hydrants and services	.....	Goose necks	5,000,000 gallons	.....
Lexington	None	.....	100	Geophone	Annually	Joints	.....	.....
Wakefield	Twice a year	Two leak detectors	None	Leak detector	Twice a year	Joints	.....	500 gal.[c]
Minnesota:								
Aurora	Twice a year	.....	2	Darley leak locator	Once a year	Joints, valves	.....	60 gal.
Missouri:								
Cameron	None	.....	100	.....	.....	Broken service pipe	.....	.....
Nebraska:								
Aurora	None	Darley leak locater, microphone	100	Darley leak locator	.....	Joints	.....	.....
New York:								
Penn Yan	None	Telephone receiver	100	Telephone receiver	When leaks reported	Near curb shut-off	20	86 gal.
Sidney	Irregular intervals	None	2.5	Let them develop	.....	Frost lifts hydrants	3 in 1924	.....
Scotia	None	.....	100	.....	.....	Valves and hydrants	No leaks	.....
Warsaw	Annually	Leak detector	Manufacturers	Detector	.....	Joints	.....	.....
Ohio:								
Ashtabula	None	.....	100	.....	.....	Service pipes	.....	120 gal.
Oklahoma:								
Hominy	Every 60 days	None	100	Shows on surface	Monthly	Joints	15% in 3 years	185 gal.
Oregon:								
Portland	Not regularly	.....	48.4	.....	.....	Joints	.....	120 gal.
Pennsylvania:								
Beaver Falls	None	.....	65	None	.....	.....	.....	120 gal.
South Carolina:								
Union	None	Show on surface	100	None	.....	Lead joints	.....	100 gal.
South Dakota:								
Mitchell	None	Meter readers	100	None	....	Joints	.....	64 gal.[a]
Watertown	None	.....	99	.....	....	Joints, old iron services	.....	75 gal.
Tennessee:								
Covington	Semi-annually	.....	30	.....	....	.....	.....	175 gal.
Dyersburg	None	.....	100	None	....	Joints	.....	75 gal.
Elizabethton	None	None	None	None	....	.....	.....	....
Fayetteville	Annually	Microphone	5	Sonoscope	2 or 3 a yr.	Lead joints	Great deal	60 gal.
Harriman	Occasionally	.....	75	.....	.....	Goosenecks, lead joints	.....	80 gal.
Jackson	Semi-annually	Sonoscope and others	10	Pitometer	....	Joints, hydrants	.....	....
Memphis	None	Aquaphone	100	None	....	Joints	Very little	70 gal.
Shelbyville	Quarterly	Steel rod detector	11.4	Steel rod detector	Semi-annually	Hydrant bases, services	.....	41 gal.

Detection of Leakage and Waste

City	How often are house-to-house examinations made?	What other methods are used for detecting leaks in services?	Percentages of services metered	Detecting underground leaks in mains: Methods employed	Frequency of surveys	Where are most underground leaks found?	How much leakage has been discovered and stopped?	Per capita Consumption per day
Texas:								
Ballinger	Monthly	.....	85	Leak detector	Annually	Joints	.....	80 gal.
Bay City	Quarterly	None	80	None	....	Lead connection joints	.....	....
Bonham	None	.....	100	None	....	Joints	.....	
Cleburne	Monthly[4]	.....	100	Watch sewers at manholes	Continually	Joints, goosenecks	200,000,000 gal. a year in 3 yrs.	31 gal.
Dallas	None	Shows on surface	100	Shows on surface	....	Services	.....	65 gal.
El Paso	.....	Dictaphone; meter readings	100	Show on surface	.....	2" goosenecks, steel pipe	.....	74 gal.
Galveston	None	.....	99	None	....	Valves	.....	80 gal.
Graham	Annually	Microphone	98	Microphone & sounding	....	Joints	.....	60 gal.
Hearne	None	Microphone	98	None	....	Joints	.....	60 gal.
Mexia	Continually	Leak locator	97	Darley leak locator	Quarterly	Joints	200,000 gal. a day	96 gal.
Orange	None	Microphone, surface indications	95	Microphone	....	Services	Very little	....
Quanah	None	None	98	None	....	Leadite joints	200 leaks	....
Sweetwater	None	Meters	100	.....	....	Joints, hydrants	.....	....
Weatherford	None	None	90	Shows on surface	....	Services	.....	....
Utah:								
Tooele	Each April	.....	6	Surface indications	Continually	Joints, broken pipe	.....	....
Vermont:								
Barre	Annually	Aquaphone	65	None	....	Joints	.....	....
Barton	....	.....	None	None	....	Hydrants	.....	....
Bennington	Annually	Microphone	Few	Leak locator	....	Joints, hydrants	.....	....
Fair Haven	Annually	Autophone	Large consumers	Listening	....	Lead connections, corroded pipe	8 in 1924	....
Morrisville	When water scarce	None	Manufacturers	Shows on surface	....	Joints	.....	....
Newport	Occasionally	Microphone	10	Shows on surface	....	Joints	.....	....
Richford	Twice a year	.....	1 meter	None	....	Joints, hydrants	.....	....
Waterbury	2 or 3 a year	None	Industrial	.....	....	Joints, hydrants	.....	....
Virginia:								
Charlottesville	None	.....	None	None	....	Joints	.....	....
Clifton Forge	Annually	None	None	None	....	Joints, valves, hydrants	.....	....
Covington	Quarterly	None	20	None	....	Joints, valves	.....	....
Martinsburg	None	.....	65	None	....	Joints	.....	90 gal.
Richmond	None	Microphone	93	.....	2 or 3 yrs.	Joints, broken pipe	.....	100 gal.
Washington:								
Aberdeen	Continually	Microphone	14	Shows on surface	....	Joints	.....	200 gal.[t]
Auburn	Annually	None	25	Electric leak locator; shows on surface	....	Wood pipe collars	.....	150-270 gal.
Bellingham	Annually	None	20	.....	....	Wood pipe	.....	400 gal.
Dayton	.....	.....	100	Shows on surface	....	.....	.....	120 gal.
Hoquiam	Annually	Audiphone, meters	60	.....	Annually	Services	.....	180 gal.
Pullman	Twice a year	Microphone	100	.....	....	Hydrants	.....	73 gal.
Ritzville	None	None	100	Shows on surface	....	Joints	2 or 3 a year	150 gal.
Tacoma	Every 2 years	Microphone and rod	14	Microphone and rod	Continually	Joints	.....	400 gal.
Tekoa	Monthly	Steel rod	100	Steel rod	Continually	Joints	.....	43 gal.
Walla Walla	Not regularly	Steel bar and teeth	40.7	.....	....	Joints	.....	157 gal.
West Virginia:								
Charleston	None	Sonoscope, transmitophone	100	.....	....	Joints	.....	114 gal.
Elkins	Twice a year	Microphone	....	Pitometer	Continually	.....	.....	113 gal.
Follansbee	.....	Darley detector	100	.....	....	.....	.....	....
Moundsville	Annually	Listening	90	.....	....	Broken pipe, services	.....	....
Salem	Twice a year	None	80	None	....	Hydrants	Very little	....
Wisconsin:								
Antigo	None	Microphone	37	Shows on surface	....	Joints, valves	Very little	50 gal.
Appleton	Quarterly	Aquaphone	100	Darley leak detector	Annually	Services	.....	71 gal.
Baraboo	None	.....	90	None	....	Broken services	.....	66 gal.
Beaver Dam	Quarterly	None	90	.....	....	Broken pipe	.....	....
Beloit	None	.....	100	.....	.....	.....	.....	.....
Clintonville	None	Listen with telephone receiver	100	Surface inspection	When consumption increases	Joints, broken pipes	20% of pumpage	37 gal.
Cudahy	None	.....	100	Darley leak locator	Annually	Joints, hydrants	.....	.....
De Pere	None	Microphone	90	None	Once a week	Hydrant valves	.....	.....
Eau Claire	Annually	Electric leak locator	96	Leak locator	....	Joints	.....	.....
Fond du Lac	None	None	87	None	....	.....	.....	60 gal.
Green Bay	Quarterly	Microphone	100	None	....	Hydrants	.....	39 gal.
Hartford	None	Microphone, meter	100	Shows on surface	....	Joints	.....	38 gal.

		records						
Janesville	.....	Meter reader	97	None	....	.....	.....	148 gal.
Kaukauna	None	Leak detector	100	.....	....	Broken pipe	.....	30 gal.
La Crosse	None	Shows on surface	98.5	Pitometer; shows on	....	Joints, lead connections	.....	103 gal.
Ladysmith	Quarterly	Aquaphone	(d)	Show on surface	.....	Goosenecks, joints	.....	55 gal.
Madison	3 years	Leak locators	99.6	Leak locator	3 years	Lead services	400,000 gal. a day	101 gal.
Manitowoc	None	Aquaphone	Commercial	None	....	Services	.....	126 gal.
Marinette	4 or 5 years	Microphone	47	Electric indicator, testing by sections	....	Old services, joints	.....	100 gal.
Menasha	None	.....	100	Darley leak locator	....	Hydrants	.....	90 gal.
Merrill	Annually	Sonoscope	25	.....	....	Joints	.....	.....
Milwaukee	None	Waterphone, electric	98.7	.....	....	Joints, broken pipe	6% since 1912	125 gal.
Mineral Point	Monthly	Microphone	100	.....	.....	Broken pipe	.....	18 gal.
Monroe	Quarterly	leak locator		None	....	.....	.....	.....
Neenah	None	Microphone	70	.....	....	Joints	.....	63 gal.
Oconomowoc	None	Microphone	99	None	....	.....	.....	.....
Plymouth	None	Microphone	100	.....	....	.....	.....	.....
Racine	Quarterly[4]	Aquaphone, Darley leak	100	Microphone	....	Hydrants	.....	.....
		locator, pitometer survey		Darley leak locator	....	Old joints	8%	80 gal.
Reedsburg	Semi-annually	Darley, aquaphone	100	Darley wireless, aquaphone	Semi-annually	Rusted services	.....	.....
Sparta	Semi-annually	.....	100	Show on surface	....	Joints	400,000 gal. a day	70 gal.[a]
Superior	Annually	Close curb stop, pump from house by hand	96	Venturi meter and hose	....	Services	Very large	64 gal.
Two Rivers	None	Sonophone	100	Sonophone	Annually	Joints, services	.....	.....
Watertown	Quarterly	Sonoscope, electric leak locator	100	Electric leak locator	Annually	Services	Very little	50 gal.
Waukesha	None	Microphone	100	.....	....	Joints	.....	.....
Wauwatosa	Annually	Microphone	100	None	....	Valves, hydrants	.....	.....
Whitewater	Quarterly	.....	90	Leak locator	....	Services	.....	.....
Wyoming								
Evanston	None	Electric leak locator	None	None	....	Joints	.....	30 gal.
Rock Springs	None	.....	100	None	....	Broken pipe	.....	48 gal.
Sheridan	None	Microphone	85	Check on reservoirs	Daily	Joints, hydrants		

a—Except city parks and buildings. b—When reading meters. c—Per service. d—When reading meters. e—All that have sewer connections. s—43 gal. in November to 85 gal. in July. t—In summer. u—210 gal. if railroad use be included.

Flood Protection on Highway Embankment

Along the eastern bank of the Delaware river —the New Jersey side—extends a highway known as Route No. 5, which serves as an approach to the Delaware Water Gap and the Pocono Mountains. This road was completed last year with a pavement of reinforced concrete mixed 1:1¾:3½, 8 inches thick throughout, 20 feet wide on light grades and 30 feet with curb on grades of 4% and over. A considerable part of this road was relocated, 40% of it being on entirely new right-of-way, whereby 2200 lineal feet was saved in a length of 5 miles. Maximum grade was reduced from 10% to 6.4% and a grade-crossing and railroad under-grade were eliminated. At one point about 1400 feet long, where the location was between the river and the Pennsylvania Railroad, the only location possible was one that was under water when the river was high. This necessitated placing the road entirely on embankment built in the river.

In making this embankment, rock was used under water, above which an earth and gravel embankment was placed with a slope on the river side of 1¼ to 1. This slope was paved with cement bags filled with sand and cement mixed 1:5, and the entire slope was then protected with a heavy rock fill. Owing to the probability of settlement, only a temporary gravel surface was placed along this stretch.

In paving with the cement-sand mixture in bags, the bags were filled by hand and slid down a wooden chute into position on the face of the embankment. The bags were then thoroughly wet down and flattened out with a wooden maul and were sprinkled at intervals for a period of three days. After five days, the placing of the heavy rock fill was begun. On September 29th and 30th, before all of the rock fill had been placed, a heavy rain caused a 17-ft. rise in the river, but no damage was done to the cement bag revetment.

The work was done by Salmon Bros., of Netcong, as contractor. The resident engineer for the state was Neil MacDougal.

Chat Roads in Missouri

Joplin, Missouri is a center of what is said to be the largest lead and zinc district in the world. These two metals as mined are found disseminated through hard flint rock formation, which is crushed to about the size of pea coal and run through machines which separate the ore from the rock, there being about thirty parts to the latter to one part of ore.

This waste rock is called chats and accumulates in huge piles around mines in the same way that culm piles accumulate around coal mines. Until recently no use had been found for these chats, but it has been discovered that they make excellent road material and 600 miles of fine road have been built of these chats, forming a network around the city of Joplin. In building these roads, Jasper County has used

Detection of Leakage and Waste

City	How often are house-to-house examinations made?	What other methods are used for detecting leaks in services?	Percentages of services metered	Detecting underground leaks in mains: Methods employed	Frequency of surveys	Where are most underground leaks found?	How much leakage has been discovered and stopped?	Per capita Consumption per day
Texas:								
Ballinger	Monthly	.....	85	Leak detector	Annually	Joints	.....	80 gal.
Bay City	Quarterly	None	80	None	....	Lead connection joints	.....	....
Bonham	None	.....	100	None	....	Joints	.....	
Cleburne	Monthly[d]	.....	100	Watch sewers at manholes	Continually	Joints, goosenecks	200,000,000 gal. a year in 3 yrs.	31 gal.
Dallas	None	Shows on surface	100	Shows on surface	....	Services	.....	65 gal.
El Paso	.....	Dictaphone; meter readings	100	Show on surface	.....	2" goosenecks, steel pipe	.....	74 gal.
Galveston	None	.....	99	None	....	Valves	.....	80 gal.
Graham	Annually	Microphone	98	Microphone & sounding	....	Joints	.....	60 gal.
Hearne	None	Microphone	98	None	....	Joints	.....	60 gal.
Mexia	Continually	Leak locator	97	Darley leak locator	Quarterly	Joints	200,000 gal. a day	96 gal.
Orange	None	Microphone, surface indications	95	Microphone	....	Services	Very little	....
Quanah	None	None	98	None	....	Leadite joints	200 leaks	....
Sweetwater	None	Meters	100	.....	....	Joints, hydrants	.....	....
Weatherford	None	None	90	Shows on surface	....	Services	.....	....
Utah:								
Tooele	Each April	.....	6	Surface indications	Continually	Joints, broken pipe	.....	....
Vermont:								
Barre	Annually	Aquaphone	65	None	....	Joints	.....	....
Barton	....	.....	None	None	....	Hydrants	.....	....
Bennington	Annually	Microphone	Few	Leak locator	....	Joints, hydrants	.....	....
Fair Haven	Annually	Autophone	Large consumers	Listening	....	Lead connections, corroded pipe	8 in 1924	....
Morrisville	When water scarce	None	Manufacturers	Shows on surface	....	Joints	.....	....
Newport	Occasionally	Microphone	10	Shows on surface	....	Joints	.....	....
Richford	Twice a year	.....	1 meter	None	....	Joints, hydrants	.....	....
Waterbury	2 or 3 a year	None	Industrial	.....	....	Joints, hydrants	.....	....
Virginia:								
Charlottesville	None	.....	None	None	....	Joints	.....	....
Clifton Forge	Annually	None	None	None	....	Joints, valves, hydrants	.....	....
Covington	Quarterly	None	20	None	....	Joints, valves	.....	....
Martinsburg	None	.....	65	None	....	Joints	.....	90 gal.
Richmond	None	Microphone	93	.....	2 or 3 yrs.	Joints, broken pipe	.....	100 gal.
Washington:								
Aberdeen	Continually	Microphone	14	Shows on surface	....	Joints	.....	200 gal.[t]
Auburn	Annually	None	25	Electric leak locator; shows on surface	....	Wood pipe collars	.....	150-270 gal.
Bellingham	Annually	None	20	.....	....	Wood pipe	.....	400 gal.
Dayton	.....	.....	100	Shows on surface	....	.....	.....	120 gal.
Hoquiam	Annually	Audiphone, meters	60	.....	Annually	Services	.....	180 gal.
Pullman	Twice a year	Microphone	100	.....	....	Hydrants	.....	73 gal.
Ritzville	None	None	100	Shows on surface	....	Joints	2 or 3 a year	150 gal.
Tacoma	Every 2 years	Microphone and rod	14	Microphone and rod	Continually	Joints	.....	400 gal.
Tekoa	Monthly	Steel rod	100	Steel rod	Continually	Joints	.....	43 gal.
Walla Walla	Not regularly	Steel bar and teeth	40.7	.....	....	Joints	.....	157 gal.
West Virginia:								
Charleston	None	Sonoscope, transmitophone	100	.....	....	Joints	.....	114 gal.
Elkins	Twice a year	Microphone	....	Pitometer	Continually	.....	.....	113 gal.
Follansbee	.....	Darley detector	100	.....	....	.....	.....	....
Moundsville	Annually	Listening	90	.....	....	Broken pipe, services	.....	....
Salem	Twice a year	None	80	None	....	Hydrants	Very little	....
Wisconsin:								
Antigo	None	Microphone	37	Shows on surface	....	Joints, valves	Very little	50 gal.
Appleton	Quarterly	Aquaphone	100	Darley leak detector	Annually	Services	.....	71 gal.
Baraboo	None	.....	90	None	....	Broken services	.....	66 gal.
Beaver Dam	Quarterly	None	90	.....	....	Broken pipe	.....	....
Beloit	None	.....	100	.....	....	.....	.....	....
Clintonville	None	Listen with telephone receiver	100	Surface inspection	When consumption increases	Joints, broken pipes	20% of pumpage	37 gal.
Cudahy	None	.....	100	Darley leak locator	Annually	Joints, hydrants	.....	.....
De Pere	None	Microphone	90	None	Once a week	Hydrant valves	.....	.....
Eau Claire	Annually	Electric leak locator	96	Leak locator	....	Joints	.....	....
Fond du Lac	None	None	87	None	....	.....	.....	60 gal.
Green Bay	Quarterly	Microphone	100	None	....	Hydrants	.....	39 gal.
Hartford	None	Microphone, meter	100	Shows on surface	....	Joints	.....	38 gal.

	records						
Janesville	None	Meter reader	97	None	....	Broken pipe	.....		148 gal.
Kaukauna	None	Leak detector	100	.....	....	.....	.....		30 gal.
La Crosse	Quarterly	Shows on surface	98.5	Pitometer; shows on surface	....	Joints, lead connections	.....		103 gal.
Ladysmith		Aquaphone	(d)	Show on surface	.....	Goosenecks, joints	.....		55 gal.
Madison	3 years	Leak locators	99.6	Leak locator	3 years	Lead services	400,000 gal. a day		101 gal.
Manitowoc	None	Aquaphone	Commercial	None	....	Services	.....		126 gal.
Marinette	4 or 5 years	Microphone	47	Electric indicator, testing by sections	....	Old services, joints	.....		100 gal.
Menasha	None	.....	100	Darley leak locator	....	Hydrants	.....		90 gal.
Merrill	Annually	Sonoscope	25	.....	....	Joints	.....		....
Milwaukee	None	Waterphone, electric	98.7	.....	....	Joints, broken pipe	6% since 1912		125 gal.
Mineral Point	Monthly	Microphone	100	.....	.....	Broken pipe	.....		18 gal.
Monroe	Quarterly	leak locator		None	....	Joints	.....		63 gal.
Neenah	None	Microphone	70	.....	....	.....	.....		....
Oconomowoc	None	Microphone	99	None	....	Hydrants	.....		....
Plymouth	None	Microphone	100	Microphone	....	Old joints	8%		80 gal.
Racine	Quarterly[a]	Aquaphone, Darley leak locator, pitometer survey	100	Darley leak locator	....				
Reedsburg	Semi-annually	Darley, aquaphone	100	Darley wireless, aquaphone	Semi-annually	Rusted services	.....		....
Sparta	Semi-annually		100	Show on surface	....	Joints	400,000 gal. a day		70 gal.[s]
Superior	Annually	Close curb stop, pump from house by hand	96	Venturi meter and hose	....	Services	Very large		64 gal.
Two Rivers	None	Sonophone	100	Sonophone	Annually	Joints, services	.....		....
Watertown	Quarterly	Sonoscope, electric leak locator	100	Electric leak locator	Annually	Services	Very little		50 gal.
Waukesha	None	Microphone	100	.....	....	Joints	.....		....
Wauwatosa	Annually	Microphone	100	None	....	Valves, hydrants	.....		....
Whitewater	Quarterly	.....	90	Leak locator	....	Services	.....		....
Wyoming:									
Evanston	None	Electric leak locator	None	None	....	Joints	.....		30 gal.
Rock Springs	None	.....	100	None	....	Broken pipe	.....		48 gal.
Sheridan	None	Microphone	85	Check on reservoirs	Daily	Joints, hydrants	.....		

a—Except city parks and buildings. b—When reading meters. c—Per service. d—When reading meters. e—All that have sewer connections. s—43 gal. in November to 85 gal. in July. t—In summer. u—210 gal. if railroad use be included.

Flood Protection on Highway Embankment

Along the eastern bank of the Delaware river—the New Jersey side—extends a highway known as Route No. 5, which serves as an approach to the Delaware Water Gap and the Pocono Mountains. This road was completed last year with a pavement of reinforced concrete mixed 1:1¾:3½, 8 inches thick throughout, 20 feet wide on light grades and 30 feet with curb on grades of 4% and over. A considerable part of this road was relocated, 40% of it being on entirely new right-of-way, whereby 2200 lineal feet was saved in a length of 5 miles. Maximum grade was reduced from 10% to 6.4% and a grade-crossing and railroad under-grade were eliminated. At one point about 1400 feet long, where the location was between the river and the Pennsylvania Railroad, the only location possible was one that was under water when the river was high. This necessitated placing the road entirely on embankment built in the river.

In making this embankment, rock was used under water, above which an earth and gravel embankment was placed with a slope on the river side of 1¼ to 1. This slope was paved with cement bags filled with sand and cement mixed 1:5, and the entire slope was then protected with a heavy rock fill. Owing to the probability of settlement, only a temporary gravel surface was placed along this stretch.

In paving with the cement-sand mixture in bags, the bags were filled by hand and slid down a wooden chute into position on the face of the embankment. The bags were then thoroughly wet down and flattened out with a wooden maul and were sprinkled at intervals for a period of three days. After five days, the placing of the heavy rock fill was begun. On September 29th and 30th, before all of the rock fill had been placed, a heavy rain caused a 17-ft. rise in the river, but no damage was done to the cement bag revetment.

The work was done by Salmon Bros., of Netcong, as contractor. The resident engineer for the state was Neil MacDougal.

Chat Roads in Missouri

Joplin, Missouri is a center of what is said to be the largest lead and zinc district in the world. These two metals as mined are found disseminated through hard flint rock formation, which is crushed to about the size of pea coal and run through machines which separate the ore from the rock, there being about thirty parts to the latter to one part of ore.

This waste rock is called chats and accumulates in huge piles around mines in the same way that culm piles accumulate around coal mines. Until recently no use had been found for these chats, but it has been discovered that they make excellent road material and 600 miles of fine road have been built of these chats, forming a network around the city of Joplin. In building these roads, Jasper County has used

millions of yards of chats at no expense except that of hauling it from the mines. At first the chats were simply distributed in a thick layer and allowed to pack under traffic. Heavier motor traffic has shown the necessity for better construction and the material is now used as aggregate for concrete base, surfaced with asphalt. Tests made by the Missouri State Highway Commission in crushing concrete cylinders have shown the chat concrete to be stronger than that made with any other available material.

Chats from Jasper Co. are used not only there but in many of the southern states other than Missouri. They can be found in use in Kansas, Texas, Louisiana, Florida and other southern states, and as far north as Iowa and Nebraska.

Vertical Pressure of Earth Fills*

Experiments being conducted by University of North Carolina and State Highway Commission, using sand and clay fills.

By C. N. Conner†

Valuable data on the vertical pressure of earth fills of various materials are expected to result from experiments now being conducted by the University of North Carolina in coperation with the North Carolina State Highway Commission.

The curves in Figure 1 show the results of some of the early experiments with sand and clay fills. It is interesting to note that greater pressures are brought to bear on the 30-inch cast-iron pipe by the clay fill than the sand fill at all depths.

The experiments are being conducted under the direction of G. M. Braune, dean of the School of Engineering, University of North Carolina, and P. K. Schuyler, associate professor of highway engineering, is actively supervising the work. The plans for the weighing scales and the general methods in use were suggested and approved by A. T. Goldbeck, chief, division of tests, United States Bureau of Public Roads.

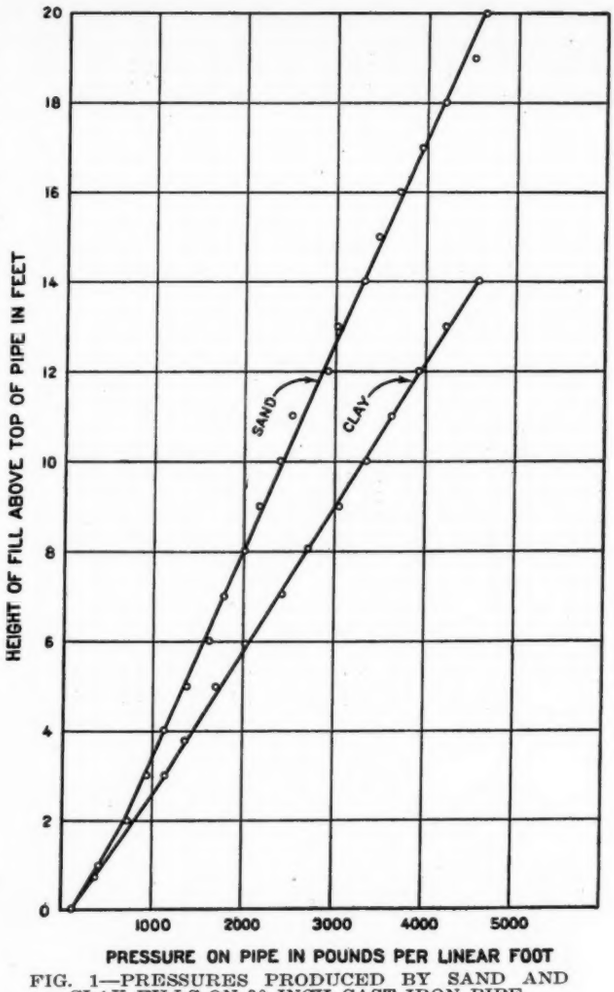
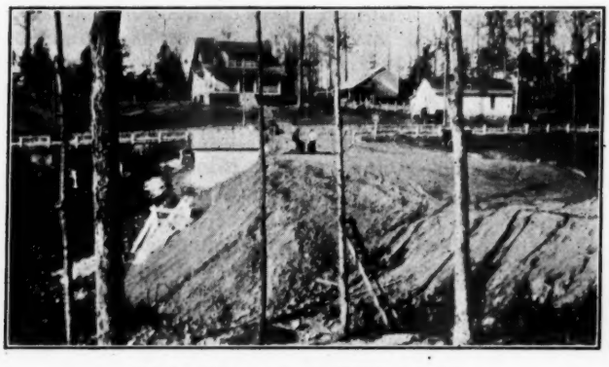


FIG. 1—PRESSURES PRODUCED BY SAND AND CLAY FILLS ON 30-INCH CAST IRON PIPE.

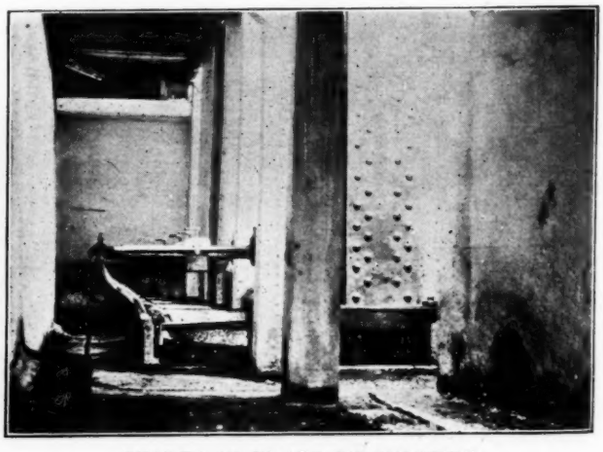
The methods used to determine the pressures are as follows: Four 2½-foot sections of 30-inch cast-iron pipe were placed on columns, which rested on the weighing platforms of specially designed scales The scales and columns were housed in a concrete culvert, in the top of which there was a slot just large enough to admit the pipe, which lay in a horizontal

*Submitted through the Highway Research Board of the National Research Council.

†State Construction Engineer, North Carolina State Highway Department.



CLAY FILL AT 13-FOOT LEVEL.



SCALES IN PLACE IN CULVERT

position, with one half of its surface protruding above the top of the culvert and exposed to the pressure of the earth fill, while the other half of its surface was inside the culvert resting on the top of the column.

A sand fill, using uniform quality of sand, was built up in 1-foot layers, each layer being carefully leveled off and the pressures accurately determined by weighing the loads on the various scales. An attempt was made to roll the sand fill, but it was not found to be practicable. The experimental fill with sand was carried to a height of 20 feet above the top of the pipe. The sand fill was then removed and replaced with a clay fill. This fill was also placed in 1-foot layers and readings taken at each foot level in a manner similar to the method employed with the sand fill. The clay fill was rolled with a 4-ton roller and carried to a height of 14 feet. The next part of the experiment as proposed will consist of using a clay fill and laying the pipe in a trench excavated after the fill is made. It is believed that by laying a pipe in this manner the pressure exerted on it by the fill is lessened.

Maj. William Cain, an authority on earth pressure, has suggested certain laboratory experiments, which are being carried out in connection with the field work. It is thus hoped to obtain data on the coefficients of friction and cohesion of soils, which can be applied to the results obtained in the field and thereby add to the present available information on the subject of earth pressure.

Some Traffic Statistics

Figures obtained from Connecticut to California show that motor truck is not invading long-haul field. It is not destroying roads.

In an address on May 28th before the Mid-West Transportation Conference, W. M. Jardine, Secretary of Agriculture, told briefly some of the facts obtained by traffic counts during the past year or two and some conclusions therefrom.

He stated that in Connecticut it had been found that nearly 40% of the total tonnage is hauled less than ten miles and nearly 70% less than thirty miles, while that which reaches or exceeds one hundred miles is chiefly the moving of furniture and household goods. Where transportation by truck exceeds thirty miles, this is due either to lack of rail service furnishing rapid and dependable transportation of L. C. L. freight, or because certain commodities, including furniture, groceries, and other food stuffs, are in their very nature adapted to motor truck shipment between cities and smaller towns.

In California it was found that 25% of the total tonnage was hauled less than ten miles, 60% less than thirty miles, and less than 20% more than seventy miles. The differences between the two States are largely those caused by greater distance between cities and less complete railroad service.

Coming to Illinois, 24% is hauled less than ten miles, 75% less than thirty miles and less than 3% moves more than one hundred miles.

These are actual figures obtained by stopping and questioning thousands of trucks. They are believed to prove conclusively that the motor truck is not invading the long-haul field. Truck operators have learned that the long haul does not pay. One of the most reputable haulage companies in the United States tried it and kept a careful record of the costs and found the result discouraging. This company operated an average of 35 trucks of about 3½ tons capacity between Buffalo and Erie and between Erie and Cleveland, a distance of one hundred miles in each case. They compared the cost of this operation with the rates of the railroad tariff, on the basis of a year's operation, and found that their loss was $14,000 on $200,000 gross revenue.

Truck hauling is distinctly a service of distribution from centers. In the main it gives a service which neither the railroads nor any other inflexible carrier, limited to a fixed line of travel, can render. It is a service which does not aim to move large bulk, day after day and year after year between the same points, but its loads are picked up everywhere and hauled anywhere within the short-haul limit.

The usefulness of the motor truck in this field is being recognized by railroad officials. The Pennsylvania Railroad is experimenting in using it as a coordinated agency for the handling of local L. C. L. freight. Operating on the zone-station principle, by which full cars of package freight are shipped to the zone stations and from these delivered to the intermediate stations by motor trucks, the company is stated to have been able to speed up its local package service and reduce by 75% the damage to goods in transit.

Mr. Jardine was quite emphatic in disputing the popular idea that motor trucks are destroying the roads. There are now as many motor trucks using the roads as there were all other kinds of motor vehicles ten years ago, but the cost of the roads per ton-mile of traffic is far less now than it was then, and the roads are better. This has been accomplished 1st, by the really notable improvements that have been made in the design of highway surface; 2nd, by the building up of efficient administrative and engineering organizations; and third, by the greatly increased use, which far exceeds the increase in the cost of the roads. During the war period trucks did destroy roads, because heavy trucks were constantly used on roads not built to accommodate them and because at the same time highway maintenance was declared to be nonessential and discouraged. Roads are built now to accommodate such traffic and, while they wear out just as rails, locomotives and motor trucks wear out, they are not destroyed.

Recent Legal Decisions

GRANT OF USE OF STREET FOR RAILROAD SWITCH

The Oklahoma Supreme Court holds, Oklahoma Tool & Supply Co. v. City of Bartlesville, 223 Pac. 637, that a grant to a railroad of the use of a city street for railroad purposes, authorized by statute, is not revocable during the time covered by the grant and while the street is being used in accordance with the terms of the grant. A railroad switch operated in connection with a main line is used for a public purpose though mainly serving one industry, and the refusal of this industry to permit an extension over its private property does not convert the switch into a private switch.

RESOLUTION FOR IMPROVEMENT HELD SUFFICIENT FINDING OF NECESSITY THEREFOR

It is the general rule that, under a statute requiring the council to find that the proposed work or improvement is necessary, the adoption of the resolution is a sufficient declaration, so that an express finding in the resolution itself as to the necessity of the work or improvement need not be made unless the statute expressly requires the resolution to contain such a recital. Hamilton's Law of Special Assessments, §342. The Montana Supreme Court, applying this rule, holds, Almas v. City of Havre, 223 Pac. 896, that, by adopting a resolution of intention, describing therein a district which includes lots which do not front on the improvement, the council declared in effect that in its opinion the proposed improvement was of more than local or ordinary public benefit.

ALTERATION OF CONTRACT AS AWARDED BY PROVISION AS TO SALE OF BONDS

The Alabama Supreme Court, Dunn. Const. Co. v. White, 96 So. 444, affirmed injunction of the enforcement of a formal paving contract as finally executed, as amounting to an alteration of the contract awarded as to the cost price, and a sale of bonds under par in violation of law. Any material departure in the contract awarded from the terms and conditions upon which the bidding is had renders the contract, in a sense, a private one, prohibited by the Alabama statute of 1915 requiring advertisement and award of contracts to the lowest bidder.

TIME LIMIT FOR SUITS TO SET ASIDE IMPROVEMENT ASSESSMENTS

The Oklahoma Supreme Court holds, Berryhill v. City of Sapulpa, 222 Pac. 555, that the 60-day period of limitation against an action to set aside an assessment for an improvement, provided for in section 471, R. L. 1910, begins to run from the date of passage of the assessing ordinance and not from the date of its last publication. The statute applies to suits involving irregularities in procedure, but not to jurisdictional defects rendering the proceedings void. The payment to a sewer contractor of more than the amount provided for in his contract, or more than a reasonable profit on the construction, or the fact that the work was not constructed according to plans and specifications, were held to be irregularities and not jurisdictional defects.

PROHIBITION OF RETAIL BUSINESS BUILDING IN RESDENTIAL NEIGHBORHOOD

The Mississippi Supreme Court holds, Fitzhugh v. City of Jackson, 97 So. 190, that it is not within the police power of a municipality to enact an ordinance prohibiting the erection of a building for business purposes (in this case a brick building to be used as a grocery store) or the conducting of a business in a residential portion of the community. The court said that the proper operation of a grocery store cannot possibly be injurious to the public health, and that, even if the state had power, under the Mississippi Constitution, under the police power to pass regulations purely to promote the public convenience or the general prosperity to the disadvantage and detriment of the individual property holders, the ordinance could not be said to promote the public convenience or the general prosperity of the municipality or its inhabitants.

In State v. City of New Orleans, 97 So. 440, the Louisiana Supreme Court reaches a contrary conclusion, holding that the provision in the state Constitution of 1921, authorizing municipalities to zone their territory and "to prohibit the establishment of places of business in residential districts" did not add anything to the authority which the Legislature already possessed.

The Louisiana court says that such an ordinance does not discriminate arbitrarily against persons owning property in the district.

The court cites three decisions of the United States Supreme Court, Hadacheck v. Los Angeles, 239 U. S. 394, Cusack v. Chicago, 242 U. S. 529, St. Louis Poster Co. v. St. Louis, 249 U. S. 269, holding that a municipal government may, for the general welfare, exercise the police power to the extent of forbidding the owners of property in a designated district to use their property for business purposes. The courts of last resort in New York, Massachusetts, New Jersey, Iowa, Utah, Missouri and Kansas, have recognized the authority of cities to enact so-called zoning ordinances, creating residential districts and commercial districts, and prohibiting business establishments in residence districts.

REVOCATON OF OFFER TO DEDICATE STREET BEFORE ACCEPTANCE

The New York Appellate Division holds, Nichols Copper Co. v Connolly, 203 N. Y. Supp, 839, that an offer to dedicate a street may be revoked or withdrawn at any time before acceptance, either actual or implied, and the death of the owner who has made the unaccepted offer operates to revoke it.

REASONABLE COMPENSATION FOR WATER SUPPLIED TOWN AFTER EXPIRATION OF CONTRACT

When the contract between a town and a water company to supply the town with water for fire protection and domestic service has expired, a legal duty arises on the part of the town, in the absence of a contract, to pay a reasonable compensation for the services rendered, and failure to compensate gives the company a right to recover upon implied assumpsit. —People v. Huntington Water Works Co., N. Y. App. Div., 203 N. Y. Supp. 808.

DEGREE OF CARE AS TO GUARDING BRIDGE BY BARRIERS

The New York Appellate Division says, Rigby v. Town of Gerry, 204 N. Y. Supp. 769, that while very likely towns are now held to a higher degree of care in the maintenance of highways and bridges and the protection of the safety of travelers than they were in the days of ox-carts or of horse-drawn vehicles, since the degree of care must be commensurate with modern conditions of traffic, primary principles of liability have not changed. The duty devolving upon the town and its officers is that of ordinary care and prudence under the existing circumstances. Negligence can be based only on an omission under these circumstances reasonably to foresee and anticipate danger, and the neglect of the duty reasonably to take necessary precautions to avert it.

In an action for the death of an automobilist whose car went over a highway bridge unprotected by a barrier, it was held that where the road was sufficiently wide for a safe passage, the driver's view was clear, and the way was open, a guard rail would have given him no more information than he already possessed and would have had to be of great strength to stop his car coming down a grade at high speed, and that a verdict for plaintiff was against the weight of evidence as to the town's negligence as a proscunate cause of the accident and the plaintiff's freedom from contributory negligence.

EXTRAS NOT ALLOWED WHERE FOR CONTRACTOR'S BENEFIT ONLY

In an action for extra yards of earth moved under a drainage contract, the Circuit Court of Appeals, Seventh Circuit, holds that the contractor could not recover unless the extra work was authorized by the drainage commissioners or their engineers and was incidental to and in beneficial furtherance of the improvement and not merely for the advantage of the contractor, as where it was necessitated by the undue width of one of his dredge boats.—Green Briar Drainage Dist. v. Clark, 292 Fed. 828.

SEWER CONTRACTOR HELD ENTITLED TO DAMAGES FOR DELAY CAUSED BY FAILURE TO PROVIDE RIGHT OF WAY

The Circuit Court of Appeals, Second Circuit, American Pipe & Construction Co. v. Westchester County, 292 Fed. 941, that a sewer contractor was entitled to damages for delay during a period of suspension of the work, caused by a delay of 258 days in furnishing a right of way, notwithstanding a provision in the contract that the commission was authorized to suspend the work at any time if they should deem it "for the best interest of the district affected," without compensation to the contractor. The commission was held bound to act with reasonable expedition in securing the right of way, and a failure to do so was a breach of the contract.

CONTRACTORS TOO LATE TO CLAIM CANCELLATION FOR MUTUAL MISTAKE ON COMPLETION OF CONTRACT

The Circuit Court of Appeals, First Circuit, City of Boston v. McGovern, 292 Fed. 705, holds that contractors for a tunnel were not entitled to cancellation of the contract after completion on the ground of mutual mistake as to the character of the soil to be excavated where the mistake was at once evident on encountering ledge and they elected to proceed and gave notice of their intention to claim extra compensation, but no notice of any intention to abrogate the contract on the ground of mistake.

MUNICIPAL ELECTRIC PLANT WITHIN KANSAS FACTORY ACT

The Kansas Supreme Court holds, Bollinger v. Hill City, 227 Pac. 265, that a municipal electric light plant wherein electric current is manufactured by means of dynamos and other machinery and conducted by wires to the municipality's customers is within the purview of the Kansas Factory Act; and a person laboring in the plant though not an employe of the municipality, but in this case learning the work with a prospect of getting a position there, is within the protection of the act, and recovery was allowed for the death of such an one injured while oiling the machinery.

RIGHT OF CONDEMNATION FOR WATER RESERVOIR IN OKLAHOMA

The Oklahoma Supreme Court holds, City of Tulsa v. Williams, 227 Pac. 876, that the right to create a water reservoir either within or without the corporate limits of municipal corporations has been conferred upon municipal corporations by the laws of Oklahoma. The necessity therefor and the location thereof are legislative questions for the law-making powers of such municipalities and are not for the courts; but the necessity for taking any particular piece of property for the public use, when that question is raised, is a matter for judicial determination. Where a municipal corporation of Oklahoma seeks to create a waterworks plant and water reservoir outside of its corporate limits, it has a right, under the law of eminent domain, to condemn such land as shall be submerged by its reservoir up to the high water line; and also has the right to condemn such margin of land above the high water line of the reservoir as may be needed, where the perpetual use and absolute control thereof is required, to protect its water supply from pollution and for policing and patrolling its reservoir; but how much margin above the high water line should be taken for such purpose is a

judicial question to be determined by the court upon evidence of the necessity.

SUBSTANTIAL PERFORMANCE OF SEWER CONTRACT

The Missouri Supreme Court holds, Lansdown v. Kierns, 260 S. W. 88, that the fact that manholes were made of secondhand ordinary brick and were not well cemented would not justify the court in holding that a sewer construction contract was not substantially performed.

CITY NOT LIABLE FOR INJURY BY DEFECTS IN FIRE STATION

The Texas Court of Civil Appeals holds, Barnes v. City of Waco, 262 S. W. 1081, that a city "is not liable in damages to a citizen who is injured by a defective fire station," and it was not liable to one who, in the fire station as an invitee of the firemen, fell through the wellhole on the second floor used by the firemen in climbing down when a fire was announced.

CITY HELD NOT LIABLE FOR INJURY TO TRESPASSER ON PREMISES

The Oklahoma Supreme Court holds, City of Grandfield v. Hammonds, 227 Pac. 140, that a city furnishing water to the inhabitants from a well on its own premises was not liable for the death of a three year old boy who, while playing about the well, which was covered with loose boards, fell into the water and was drowned, the child being on the premises without invitation, express or implied, of the owner.

UPKEEP OF HIGHWAYS AND BRIDGES IN PENNSYLVANIA

The Circuit Court of Appeals, Third Circuit, holds, Tioga County, Penn., v. Bohnett, 299 Fed. 103, that at common law and under the Pennsylvania statutes, the duty to keep a public highway in repair devolves upon the township upon which rests the duty of opening and making it. A county is generally recognized as a quasi corporation, upon which duties wholly involuntary are imposed. They possess no power to incur obligations not authorized by statute. In Pennsylvania there is no common law duty imposed upon countries to build or repair highways or bridges; such duty and consequent liability for negligence in the care thereof must be imposed by statute or held not to exist. The statutory requirements imposed as a requisite to establish a bridge as a county bridge must be complied with, or all the proceedings fail.

ACQUIESCENCE BY ABUTTING OWNER TO IMPROVEMENT IN FRONT OF PROPERTY

The Louisiana Supreme Court holds, Foster v. City of New Orleans, 99 So. 686, that where a property owner saw the construction of a swimming pool by the city in front of his property going on, but made no objection until it was completed, he was estopped from demanding removal of the pool, but not from claiming damages, under article 167 of the State Constitution of 1913, then in force, "because the municipal government had the right to establish the swimming pool as a public institution, provided the city paid just and adequate compensation for the private property thereby taken or damaged."

MUNICIPALITY'S RIGHT TO REMOVE SHADE TREES IN STREETS

While an abutting owner has a qualified interest in trees in front of his premises to such an extent that he can recover damages to his property caused by the wrongful interference with the shade trees, the New York Supreme Court, Special Term, Erie County, holds, Cary v. Schwab, 123 Misc. 536, 205 N. Y. Supp. 903, citing Donahue v. Keystone Gas Co., 181 N. Y., 313, that he has no proprietary interest which prevents the city from improving the street to the extent of removing the trees, so as to afford the full benefit to the public which was contemplated when the fee or easement to the street was acquired, and to meet the changed conditions incident to the growth of the city, the increase in travel and the changed means of travel.

LETTING TO LOWEST RESPONSIBLE BIDDER—RIGHT OF AGGRIEVED BIDDER

The Louisiana Supreme Court holds, St. Landry Lumber Co. v. Mayor, etc., of Town of Bunkie, 99 So. 687, that Section 2 of Act No. 147 of 1902, providing for the letting of municipal contracts to the lowest responsible bidder "vests in the council the power and discretion to determine, first, the responsibility of the bidder, secondly, whether the security offered is satisfactory, and, thirdly, it may reject all bids if none is satisfactory; but the law does not permit the arbitrary selection of one which is higher and the rejection of others which are lower, and made by persons more responsible and better qualified to do the work." It holds that the responsibility of the bidder is to be determined not only by his financial ability to perform the work, but his experience and reputation for satisfactory work are of equal importance. An unsuccessful bidder, alleging his bid to have been the lowest and his responsibility good, has a standing in court, under the statute, to assail the action of the municipal authorities in refusing to award him the contract.

AUTHORITY TO SELL PUBLIC SQUARES

The Kansas Supreme Court holds, State v. City of Manhattan, 225 Pac. 85, that chapter 97 of the Laws of 1921, authorizing cities to sell any public park, public square, or market square that "they may now own," does not authorize a city to sell such property dedicated by the filing of plots of the city, the city not having complete ownership of such property.

MUNICIPAL CONTRACT MAY MAKE PRICE PAYABLE IN INSTALLMENTS

The Oklahoma Supreme Court holds, City of Woodward v. Manhire Grate & Equipment Co., 224 Pac. 356, that if the contract of a municipal corporation for machinery and equipment for use in making a water and light extension is otherwise legal in every respect, it will not be invalidated by the fact that it provides for the payment of the price in monthly installments to commence at some future date.